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CONTRACTOR PROTOTYPE QUALIFICATION TEST (PQT-C) M60A1(PI) TANK --ETC(U)
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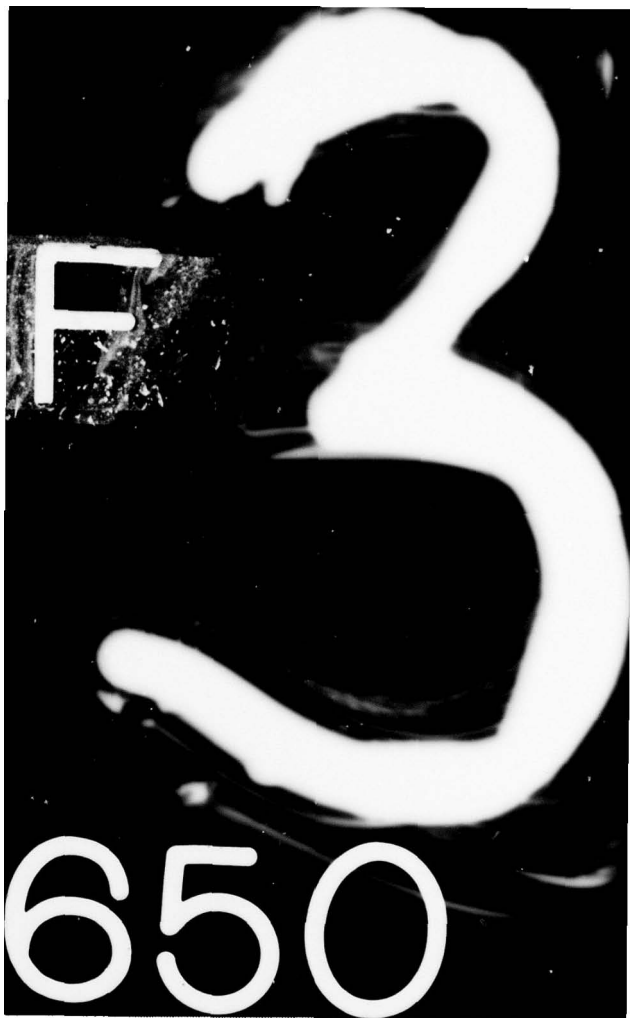
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PREPARED FOR

ARMY MATERIEL COMMAND
PROJECT MANAGER-M60 TANKS

BY

DEFENSE DIVISION

CHRYSLER CORPORATION

(1)

(9) Final Report,
For
(6) Contractor Prototype
Qualification Test (PQT-C)
M60A1(PI) Tank Thermal Sight (TTS)
AN/VSG-2 .

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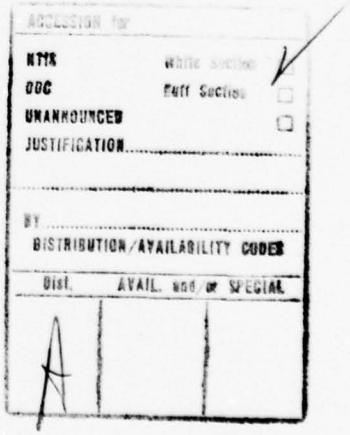

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M60A1(PI) TANK THERMAL SIGHT (TTS) AN/VSG-2

1.0 PREFACE

This report summarizes the results of the contractor Prototype Qualification Test (PQT-C) for the Tank Thermal Sight (TTS). This testing was conducted from 20 July to 12 September 1977 at Fort Knox.

The M60A1(PI) Tank Thermal Sight (TTS), integrated day/night gunner's periscope, provides the commander and gunner of the M60A1(PI) tank with an improved capability for target acquisition, recognition and fire control at night. The requirement for passive operation for long range detection, recognition, and engagement precludes the use of existing image intensification devices, which require active sources of illumination for satisfactory long range operation.

The Tank Thermal Sight (TTS) Program was started in July 1974 with contracts being awarded to Hughes Aircraft Company and Texas Instruments (TI) Incorporated for two (2) systems each. The TTS Program is a continuation of the TINTS Program. Its goal is to provide a long range passive night fighting capability with a thermal imaging system designed as a direct replacement for the M35E1 Periscope on the M60A1(PI) Tank. Additional goals of the TTS are to provide longer range capability during periods of adverse weather and a higher reliability than that of the TINTS. DT/OT-1 testing was conducted at Aberdeen Proving Grounds in 1975, resulting in selection of the TI system for ED hardware procurement.

The PQT-C test hardware consisted of 3 M60A1(PI) DT/OT II turrets refurbished and updated to the production M60A1E3 configuration and mounting the TTS development hardware. The hulls were M60A1 RISE BART chassis configuration. The M60A1(PI) TTS Periscope is an integrated day/night periscope system. The system consists of five (5) major assemblies: Head Assembly, Gunner's Display, Commander's Display, Power Converter, and Mount. The TTS provides an 8X visible channel, a 1X unity window, and a dual field of view thermal channel which can be used for viewing during both the day and night time. The system is fully integrated with the tank fire control computer and laser rangefinder. The mount interfaces the Head Assembly with the tank. The Head Assembly contains the entrance window and mirror for the visible and thermal channels, as well as the afocal and the far infrared common modules that convert the IR radiation into an electronic signal and then into a visible image on the light emitting diodes. The Gunner's Display contains the 8X channel, the 8X and thermal reticle projector assembly and projection optics, the thermal channel image intensifier and biocular eyepiece. The Commander's Display contains the relay optics, and image intensifier and biocular eyepiece. The power converter contains all the electronics necessary to convert the tank power (18-30 vdc) into the voltages required to operate the components of the head assembly, gunner's display and commander's display.

The prototype Qualification Test-Contractor vehicles also had numerous M60A1(PI) improvements that were evaluated in conjunction with the TTS system. Refer to Section 11.0 of this document for results of this evaluation.

The PQT-C initiated the Development Test II (DT II) portion of the TTS System/Field Tests. This Test was conducted concurrently with the PQT-G (Desert Phase) Test at Yuma Proving Ground. Upon completion of PQT-C, the three Tank Thermal Sight units are to be installed in M60A1 Tanks and subjected to further testing in PQT-G at Aberdeen Proving Ground. Three new ED Configuration TTS units will be installed in the PQT-C M60A1(PI) test vehicles for continued testing in OT II.

2.0 OBJECTIVES

Chrysler Warren Defense Division, as TTS integration contractor, tested three Engineering Development configuration tank thermal sight systems installed in M60A1(PI) vehicles for 1500 miles at an established level usage which included firing 300 main gun rounds per vehicle. The critical issue was the increasing of the confidence level by the Government/-contractor team in the ability of the TTS system to continue DT II/OT II testing successfully.

The specific test objectives were:

a. To obtain quantitative data on the performance of the TTS system.

b. To determine the effects of shock and vibration on system performance, through the use of road operations, firing, field handling and surveillance operations.

c. To obtain quantitative data on reliability and maintainability of the M60A1(PI) vehicle with an integrated TTS system.

3.0 TEST SUMMARY

The general objectives of the PQT-C were met or exceeded in all significant respects. The total TTS system operation is presented below:

TABLE 3-1. PQT-C TEST USAGE

TEST TANKS

	PQ-1	PQ-2	PQ-3
Total Test Mileage	1550 Miles	1535 Miles	1530 Miles
TTS on-Time	417 Hours	407 Hours	420 Hours
Total Main Gun Rounds Fired	409 Rds	329 Rds.	338 Rds

Results of the various elements of the PQT-C program are discussed below in summary. Detail information is provided in the appropriate sections of this report.

3.1 RAM DEMONSTRATION

The TTS system has demonstrated an unadjusted Mean Time Between Failure of 49.8 hours, without MRF. This assessment is based on 25 incidents occurring during the 1244 hours of operations. Two incidents are still considered "open" and may impact this TTS MTBF assessment. The TTS reliability assessment, by assembly, is as follows:

TABLE 3-2. PQT-C TTS SYSTEM RELIABILITY ASSESSMENT

Assembly	Minimum Acceptable MTBF	Demonstrated MTBF
Head Assembly	1250.0 Hours	124.4 Hours
Gunner's Display	1612.5 Hours	138.2 Hours
Commander's Display	1666.5 Hours	311.0 Hours
Power Converter	3900.0 Hours	≥1244.0 Hours
Installation Kit	4477.0 Hours	622.0 Hours
Overall TTS System	400.0 Hours	49.8 Hours

Assessment of the quantitative maintainability characteristics demonstrated during PQT-C are presented in Table 3-3. These characteristics are based on an accumulation of 1244 hours (TTS Periscope On Time). A majority of the TTS system maintenance actions involved seal leaks, burned out reticle lamps, and mechanical/optical problems. It should be noted that reticle lamp replacements require removal of the Gunner's Display Assembly. The Gunner's Display Assembly must be purged subsequent to reticle lamp replacement and reinstallation.

The TTS internal component Mean Time Between Corrective Maintenance (MTBCM) is low. The associated high repair times of internal TTS components (i.e. circuit boards, optics, head mirror, seals) has resulted in relatively high MTTR and Mmaxt at the direct support level of maintenance. The TTS reticle lamp replacements upped the organizational level MTTR and Mmaxt, due to non-incorporation of quick attach/detach type fasteners.

TABLE 3-3. PQT-C TTS Mean-Time-To-Repair (MTTR) and Maximum Corrective Maintenance Downtime (Mmaxt)

	Organizational		Direct/General Support	
	Requirement	Demonstrated	Requirement	Demonstrated
MTTR	.25 Hrs.	0.94 Hrs.	1.0 Hrs.	1.85 Hrs.
Mmaxt 95%	.5 Hrs.	2.77 Hrs.	2.0 Hrs.	4.30 Hrs.

Refer to the Preliminary Reliability Availability Maintainability Report No. 4, dated October 1977 for detailed RAM analysis.

3.2 SYSTEM VERIFICATION

The boresight measurements, taken as a function of the main gun firing exercise, indicates shifts in TTS boresight. Similar shifts were, however, noted in other fire control optics. The limited test data does not provide conclusive data of a significant TTS boresight problem. One unit (TTS S/N 005) did exhibit boresight problems as a result of the final specification check boresight retention test.

The built-in "BITE" test was utilized as a system monitor during the testing. Many of the failures that occurred, i.e. seal leakage, lamp bulbs and mechanical/optical problems; could not be identified by this test. Problems indicated by the "BITE" test were not isolated to the proper component or subsystem.

Results of road vibration, firing shock, and electrical transient/EMC testing are abstracted in this report and detailed in separate test reports.

3.3 FIRING TESTS

The main gun firing tests conducted with the TTS daylight and thermal channels provided equivalent results to those previously obtained with the M60A1(PI). Refer to the separate Classified Final Test Report, TTS Main Gun Firing, dated 5 December 1977.

3.4 SURVEILLANCE TEST

The TTS thermal channel meets the requirements for night vision surveillance capability. Refer to Final Test Report; TTS Target Acquisition Test, dated 5 December 1977.

4.0 TEST METHOD

The contractor PQT activity was organized as an on-site test group directed by a Project Test Engineer. The Project Test Engineer was supported by Vehicle Test Engineers, Test crews, and technicians as required. All routine events and all incidents of malfunction/-failure were reported on the Daily Driver's Report. Incidents of malfunction and failure were reported by the vehicle Test Engineer on Interim Reports - Test Problem/Malfunction (ITR). The ITR is forwarded to Chrysler Warren Defense Division for failure analysis and preparation of a formal ITR - Closeout Report. The ITR reports and closeouts provide the data base for analysis by Reliability personnel to determine whether the incidents reported were chargeable or non-chargeable failures. A summary of the ITR's generated during PQT-C is tabulated in the Reliability Test report section of this document:

The three test tanks utilized in the test program were designated:

Tank No.	Hull S/N	Turret S/N	TTS Set S/N
PQ-1	7403	G234	5
PQ-2	7406	U676	6
PQ-3	7415	U664	3

The tanks were operated by two man crews per the function and usage matrices defined in the Reliability Test Report. A typical test day commenced with before operation safety and preventative maintenance checks in accordance with the Operator's Manual. Verification of system performance was checked during the running via the built-in system tests and during firing exercise by actual application of the systems. Before and after the testing a modified specification check was performed. One quarterly maintenance service was conducted at mid-test. The following engineering measurement programs were conducted in support of the Systems Verification Testing:

- o Evaluation of electromagnetic compatibility and the effects of input voltage levels on the TTS system.
- o Measurement of the road vibration levels on TTS components.
- o Measurement of main gun firing shock on TTS components.

The results of these measurement programs are abstracted in the appropriate section of this document.

The armament firing exercises were conducted by Fort Knox firing crews. The exercises included zeroing, dispersion, and hit performance tests with kinetic and HEAT ammunition. The results of these tests are documented in a separate Armament Firing Report referenced within this report.

Target acquisition tests were also conducted using the Fort Knox firing personnel. This testing was conducted by the Night Vision Laboratory using their automated scoring equipment. The test results are also presented under a separate report.

5.0 RELIABILITY TEST REPORT

5.1 OBJECTIVES

The objectives of the PQT-C Relability Testing were:

a. Accumulation of 1,500 miles of endurance operation at an average of 10 mph as shown in the tabulation below. Approximately 30 percent of the mileage will be in stabilized mode.

Mileage	Estimated Tank Speed (mph)	Percentage of Total Mileage	Course Type
420	10 - 20	28	Paved
540	5 - 10	36	Secondary
540	2.5 - 10	36	Level Cross-Country
1500			

b. Operation of the vehicle system and/or subsystems to the following level of usage goals; all hours will be counted, including time expended in specifications and system verification testing.

- o TTS System
  - Standby operation 100 hrs.
  - Thermal mode on-time 400 hrs.
- o Other Tank Systems
  - Engine operating time 375 hrs.
  - Time in motion 150 hrs.
  - Master relay on-time 500 hrs.
  - Turret power on-time 500 hrs.
  - Stabilization system standby time 500 hrs.
  - Stabilization system on-time 45 hrs.
  - Driver's night viewer on-time 100 hrs.
  - Computer on-time 500 hrs.

c. Acquisition of RAM test data from the field; i.e., failures, operating time, number of actuations, and system performance level; for reliability analysis.

5.2 CONCLUSIONS

Durability operation of three test tanks achieved the 1500 mile, 400 hour TTS on-time objectives. Other system/subsystem usage levels were generally short of target goals. This was due in part to a shortened period of test and operation of tanks at a higher average speed than projected. Stabilized operation was also limited because some of the durability courses did not allow safe operation in stab mode.

Reliability data was documented with the reporting of 346 incidents of malfunction or failure and corrective actions associated therewith.

5.3 TEST DISCUSSION

5.3.1 Schedule

The three test tanks were scheduled for a three month period of test. This time frame was shortened due to delays in hardware availability. The actual durability test start and completion dates are shown below:

CONTRACTOR PROTOTYPE QUALIFICATION TEST SCHEDULE

		Start of Test		Durability Test Completion	
Test Tank No.	Serial No.	Planned	Actual	Planned	Actual
PQ 1	7403	7/5/77	7/19/77	9/20/77	9/07/77
PQ 2	7406	7/7/77	7/19/77	9/23/77	9/12/77
PQ 3	7415	7/8/77	7/20/77	9/23/77	9/06/77

The planned and implemented schedule was based upon the following operational planning:

a. Tanks were operated with a two man crew with the test engineer acting as a relief crew member and/or test monitor by assuming loader's position (Total of 3 men assigned to each test tank).

b. Operation of the tank was in accordance with a durability matrix which will establish a desired level of usage.

c. A six day week was worked throughout the test program. The vehicles operated on two 8 hour shift basis; one shift firing and the second for endurance running and/or maintenance. Saturdays utilized as required to perform maintenance or makeup mileage and operating time.

d. The test program schedule was controlled by the firing dates established.

e. Two quarterly maintenance services were performed during the test period.

5.3.2 System/Subsystem Usage

A 25 mile usage matrix, Table 5-1, was developed for contractors Engineer Test and presented in the test plan. The matrix when cycled through 1500 test miles would provide a test usage equal to or greater than that predicted for normal Government Engineering and Service Tests. The usages were recorded daily by timers and counters placed in the vehicle. Usage objective and results are presented in Table 5-2.

Mile	Activity	Status		Turret Mode			Fire Control			Drivers
		Stat	Mov	Pwr	SSB	Stab	LRF/ SSC	TTS Stndby	TTS On	Night Viewer
1-10	Gun over the front of the tank		X	X	X		X		X	X
	System Check	X		X			X		X	X
11-20	Gun over the Rear Deck		X	X	X		X	X		
	System Check	X		X	X		X	X		X
21-25	Searching - Gunner Moves main gun randomly		X	X		X	X		X	X
	System Check	X		X		X	X		X	X

Table 5-1. Durability Test Matrix

NOTE: 1.0 System check consists of traverse and elevate main gun and utilization of TTS system for image resolution on existing targets. The TTS and LRF/ SSC bite test is to be performed along with periodic checks of other turret systems.

2.0 Drivers night viewer to be utilized for all night driving.

5.3.3 Durability Mileage

The mileage test objective of the Contractor Test program was the accumulation of 1500 miles. Table 5-3 shows the Durability Test miles, planned versus actual. The test logs for the contractor test tank are summarized in Tables 5-4 through 5-6. The test logs shows the date, operation, daily mileage, and accumulated mileage. The log also shows associated tests, firing, performance and Engineering tests. Unscheduled maintenance is identified with an ITR Number for which a failure report was written.

5.3.4 Reliability Data

Daily Status Reports, Daily Driver Reports, and Vehicle Test Usage Summary sheets were prepared daily for each vehicle during the test period. Interim Report, Test Problem/-Malfunction (ITR) were prepared for all incidents of malfunction and sub-standard performance discovered during the testing. A total of 346 ITR's were prepared and chronologically listed in the summary of incident of Malfunction Reports, by tank in Tables 5-7 through 5-9. A TTS Durability Log, Table 5-10, shows the daily and accumulated test time of TTS Periscopes in the three test vehicles and the final test time for the converter. A Driver's Night Viewer Operations Log, Table 5-11, shows the daily and accumulated test time of the night viewer.

5.3.5 Maintainability Data

Maintenance actions are identified in the Durability Test Log, Tables 5-4 through 5-6, and incident of Malfunction Summary, tables 5-7 through 5-9.

A Log of the Fuel Consumption for the test period was recorded and is shown in Table 5-12 through 5-14. The new hardened end connectors were tested on contractor test vehicles PQ-2 and PQ-3. Track tensions on the three test tanks were monitored and adjusted to test tensions as indicated in Table 5-15. The table shows adjustment tension, after operation tension and mileage between tension checks.

TABLE 5-2. DURABILITY TEST SUMMARY

	Test Vehicle			
	PQ 1	PQ 2	PQ 3	Target Usage
TEST MILEAGE				
Paved	471.1	443.6	409.9	420
Secondary	539.1	542.3	579.7	540
Cross Country	540.0	549.5	540.3	540
Total Mileage	1550.2	1535.4	1529.9	1500
ACTUATIONS (TOTAL)				
Lases	666	535	548	**
Hydraulic Power Pack	4439	11512	1934	**
Turret Brake	*	3938	4797	**
TIME (TOTAL)				
Driver's Night Viewer	12.5	12.0	12.5	100 hrs.
Engine Operating	203.6	198.1	*	375.0
Vehicle in Motion	118.0	117.8	*	150 hrs.
Master Relay On	416.1	489.2	*	500 hrs.
Turret Power On	322.2	272.3	323.6	500 hrs.
Stab. Standby	153.8	122.7	149.5	500 hrs.
Stab On	6.4	13.9	*	45 hrs.
Hyd. Power Pack On	2.3	4.4	*	**
LRF On	277.9	*	326.5	**
Computer On	305.6	304.9	330.0	500 hrs.
TTS Periscope	417.0	407.0	420.0	400

* Counter Inoperative
** No Target Usage Established

TABLE 5-3.

TEST MILEAGE ACCUMULATION

TANK NO	PAVED		CROSS COUNTRY		SECONDARY		TOTAL	
	PLAN	ACTUAL	PLAN	ACTUAL	PLAN	ACTUAL	PLAN	ACTUAL
PQ-1	420	471.4	540	540	540	539.1	1500	1550.5
PQ-2	420	452.2	540	549.5	540	542.2	1500	1544.0
PQ-3	420	417.2	540	540.3	540	579.7	1500	1537.2
TOTAL	1260	1340.8	1620	1629.8	1620	1661.0	4500	4631.7

TABLE 5-4

DURABILITY TEST LOG

PROGRAM PQT-C

TANK MODEL P8-1 S/N 7403

DATE	REMARKS	LOCATION	MILEAGE								ASSOCIATE TESTS			MAINTENANCE	
			TOTAL		PAVED		SECONDARY		CROSS-COUNTRY						
			DAILY	ACCUM.	DAILY	ACCUM.	DAILY	ACCUM.	DAILY	ACCUM.	PERF.	FIRING	ENGR.	SCHED.	UNSCHEDULED
7/19	PROOF FIRED	KNOX	14.1	14.1	6.0	6.0	8.1	8.1				3-HEAT			ITR TO016 & TO017
7/20	ZERO	"	14.0	28.1	6.0	12.0	8.0	16.1				16-HEAT 11-TPDS			ITR TO019 THRU TO023
7/21	FIRING SHOCK	"	14.0	42.1	6.0	18.0	8.0	24.1				47-HEAT	FIRING SHOCK ROAD 118		ITR TO027 THRU TO029
7/22	ROAD VIBRATION	"	28.5	70.6	28.5	46.5	0	24.1							
7/23	MAINT/DURABILITY	"	36.7	107.3	14.0	60.5	7.0	31.1	15.7	15.7					
7/25	DURABILITY	"	73.4	180.7	25.2	85.7	29.0	60.1	19.2	34.9					
7/26	FIRING/DURABILITY	"	52.0	232.7	12.0	97.7	26.0	86.1	14.0	48.9		18-HEAT 14-TPDS			
7/27	" "	"	64.0	296.7	20.0	117.7	30.5	116.6	13.5	62.4		17-HEAT 10-TPDS			ITR TO042
7/28	MAINT/DURABILITY	"	49.1	345.8	21.0	138.7	10.5	127.1	17.6	80.0					ITR TO043,46,47,49,50
7/29	" "	"	44.4	390.2	44.4	183.1	0	127.1	0	80.0					ITR TO051
7/30	" "	"	53.6	443.8	15.2	198.3	6.7	133.8	31.7	111.7					
8/1	MAINT/FIRING	"	14.1	457.9	8.0	206.3	6.1	139.9	0	111.7		27-HEAT 6-TPDS			ITR TO055,56
8/2	MAINT/FIRING/DURA	"	72.5	530.4	26.1	232.4	46.4	186.3	0	111.7		12-HEAT			ITR TO060
8/3	" " "	"	81.0	611.4	22.4	254.8	25.8	212.1	32.8	144.5		41-TPDS			ITR TO064,65
8/4	" " "	"	56.0	667.4	19.4	274.2	10.4	222.5	26.2	170.7					ITR TO073
8/5	" " "	"	56.1	723.5	17.0	291.2	11.0	233.5	28.1	198.8		26-HEAT			ITR TO078,79,80,88
8/8	SURVEILLANCE/MAINT	"	13.8	737.3	6.0	297.2	0	233.5	7.8	206.6	SURVEIL.				ITR TO089,93,99
8/9	" "	"	14.3	751.6	6.0	303.2	8.3	241.8	0	206.6	SURVEIL.				
8/10	@ SERVICE	"		751.6		303.2		241.8		206.6				@-SERVICE	TO085, ITR TO098,99,107,109,114,
8/15	DURABILITY	"	56.4	808.0	8.0	311.2	6.0	247.8	42.4	249.0					ITR TO127,129,130
8/16	"	"	93.8	901.9	11.1	322.3	34.7	282.5	48.1	297.1					ITR TO134
8/17	DURABILITY/FIRING	"	42.7	944.6	0	322.3	34.0	316.5	8.7	305.8		10-HEAT			ITR TO138,141,142
8/18	" "	"	24.3	968.9	4.0	326.3	8.0	324.5	12.3	318.1		23-HEAT			
8/19	MAINT/FIRING	"	13.9	982.8	7.0	333.3	6.9	331.4	0	318.1		26-TPDS			ITR TO156,157,158,160
8/22	FIRING/DURABILITY	"	38.1	1020.9	7.0	340.3	6.9	338.3	24.2	342.3		24-HEAT			ITR TO161,162,165,171
8/25	DURABILITY/MAINT	"	64.3	1085.2	17.1	357.4	13.9	352.2	33.3	375.6					TO187, TO188 ITR TO174,180,181,182

TABLE 5-4 (CONT)

DURABILITY TEST LOG

PROGRAM PQT-C

TANK MODEL PQ-1 S/N 7403

DATE	REMARKS	LOCATION	MILEAGE								ASSOCIATE TESTS			MAINTENANCE	
			TOTAL		PAVED		SECONDARY		CROSS-COUNTRY						
			DAILY	ACCUM.	DAILY	ACCUM.	DAILY	ACCUM.	DAILY	ACCUM.	PERF.	FIRING	ENGR.	SCHED.	UNSCHEDULED
	FROM SHEET 1			1085.2		357.4		352.2		375.6					
8/26	DURABILITY/MAINT	KNOX	66.4	1151.6	14.2	371.6	6.1	358.3	46.1	421.7					ITR TO 209, 210, 211, 260
8/29	" "	"	123.6	1275.2	27.0	398.6	64.7	423.0	31.9	453.6					ITR TO 212, 213
8/30	FIRING/DURABILITY	"	68.4	1343.6	0	398.6	68.4	491.4	0	453.6		2S HEAT			ITR TO 216, 217, 218
9/1		"	7.4	1351.0	3.9	402.5	3.5	494.9	0	453.6					
9/2		"	54.0	1405.0	11.5	414.0	3.1	498.0	39.4	493.0		1B HEAT			ITR TO 220, 230, 231, 235, 236, 237
9/6	DURABILITY/MAINT	"	28.4	1433.4	16.0	430.0	6.8	504.8	5.6	498.6					ITR TO 245
9/7	" "	"	84.2	1517.6	16.5	446.5	26.3	531.1	41.4	540.0					ITR TO 250, 256, 257
9/8		"	.2	1517.8	.2	446.7	0	531.1	0	540.0					ITR TO 263
9/9		"	.9	1518.7	.9	447.6	0	531.1	0	540.0					ITR TO 268
9/10	TO MEO	"	7.0	1525.7	3.0	450.6	4.0	535.1	0	540.0					
9/12	FROM MEO	"	7.0	1532.7	3.0	453.6	4.0	539.1	0	540.0					ITR TO 281
9/13	SPEC CHECK	"	16.7	1549.4	16.7	470.3	0	539.1	0	540.0	SPEC CHECK				ITR TO 301
9/14	" "	"	0.5	1549.9	0.5	470.8	0	539.1	0	540.0	"				ITR TO 304, 305
9/15	" "	"	0.3	1550.2	0.3	471.1	0	539.1	0	540.0	"				
9/16-20	EMC	"	0.3	1550.5	0.3	471.4	0	539.1	0	540.0			EMC		

TABLE 5-5

DURABILITY TEST LOG

PROGRAM PDT-C

TANK MODEL PD-2 S/N 7406

SHEET 1 OF 2

DATE	REMARKS	LOCATION	MILEAGE								ASSOCIATE TESTS			MAINTENANCE	
			TOTAL		PAVED		SECONDARY		CROSS-COUNTRY						
			DAILY	ACCUM.	DAILY	ACCUM.	DAILY	ACCUM.	DAILY	ACCUM.	PERF.	FIRING	ENGR.	SCHED.	UNSCHEDULED
7/19	PROOF FIRED	KNOX	14.1	14.1	6.0	6.0	8.1	8.1				9-HEAT			ITR T0015, 18
7/20	ZERO	"	14.0	28.0	6.0	12.0	8.0	16.1				11-HEAT 11-TPDS			ITR T0019, 20, 21, 24
7/21	DURABILITY	"	60.7	88.8	6.0	18.0	8.0	24.1	46.7	46.7					ITR T0030
7/22	"	"	30.6	119.4	23.6	41.6	7.0	31.1	0	46.7					ITR T0031, 32
7/23	VIBRATION	"	38.5	157.9	28.0	69.6	7.1	38.2	3.4	50.1			ROAD VIBRATION		ITR T0033, 35
7/25	FIRING SHOCK	"	48.1	206.0	40.1	109.7	8.0	46.2	0	50.1		36-HEAT	FIRING SHOCK		ITR T0034, 36
7/26	FIRING/DURABILITY	"	54.6	260.6	6.0	115.7	48.6	94.8	0	50.1		14-HEAT 13-TPDS			
7/27	" "	"	28.9	289.5	13.4	129.1	15.5	110.3	0	50.1		17-HEAT 10-TPDS			ITR T0039, 49
7/28	MAINT	"	1.2	290.7	1.2	130.3	0	110.3	0	50.1					ITR T0051
7/29	"	"	0	290.7	0.0	130.3	0	110.3	0	50.1					
7/30	MAINT/DURABILITY	"	29.4	320.1	14.0	144.3	7.0	117.3	8.4	58.5					
8/1	MAINT/DURABILITY	"	5.1	325.2	5.1	149.4	0	117.3	0	58.5					ITR T0052, 53, 54
8/2	MAINT/FIRING	"	30.0	355.2	11.1	160.5	18.9	136.2	0	58.5		23-HEAT			ITR T0059, 61, 62, 63
8/3	" "	"	14.3	369.5	6.5	167.0	7.8	144.0	0	58.5		42-TPDS			ITR T0066, 67, 68, 72
8/4	DURABILITY/MAINT	"	40.9	410.4	7.0	174.0	6.9	150.9	27.0	85.5					ITR T0074, 75
8/5	FIRING/DURABILITY	"	45.6	456.0	17.0	191.0	11.0	161.9	17.6	103.1		19-HEAT			ITR T0087, 88
8/6	DURABILITY	"	84.8	540.8	14.3	205.3	7.2	169.1	63.3	166.4					ITR T0081, 82, 85, 86
8/8	SURVEILLANCE/MAINT	"	13.5	554.3	0	205.3	6.5	175.6	7.0	173.4	SURVEIL.				ITR T0092, 95
8/9	" "	"	14.0	568.3	6.0	211.3	8.0	183.6	0	173.4	"				
8/10	Q SERVICE	"		568.3		211.3		183.6		173.4				Q-SERVICE	ITR T0112, 113, 118 THRU 125 ITR T0100, 101, 102, 103, 108
8/15	FIRING/DURABILITY	"	24.2	592.5	7.1	218.4	8.0	191.6	9.1	182.5		18-HEAT			ITR T0116, 117
8/16	DURABILITY	"	80.5	673.0	7.0	225.4	42.0	233.6	31.5	214.0					ITR T0131, 135, 136, 137
8/17	DURABILITY/FIRING	"	40.2	713.2	0	225.4	40.2	273.8	0	214.0		8-TPDS			ITR T0139
8/18	MAINT/FIRING	"	14.9	728.1	8.0	233.4	6.9	280.7	0	214.0		27-HEAT 23-TPDS			
8/19	MAINT/DURABILITY	"	42.0	770.1	7.0	240.4	6.9	287.6	28.1	242.1					ITR T0151, 152, 153, 154, 155
8/22	" "	"	30.7	800.8	4.0	244.4	3.0	290.6	23.7	265.8					ITR T0159, 169

TABLE 5-5 (CONT)

DURABILITY TEST LOG

PROGRAM PQT-C

TANK MODEL PQ-2 S/N 7406

DATE	REMARKS	LOCATION	MILEAGE								ASSOCIATE TESTS			MAINTENANCE	
			TOTAL		PAVED		SECONDARY		CROSS-COUNTRY						
			DAILY	ACCUM.	DAILY	ACCUM.	DAILY	ACCUM.	DAILY	ACCUM.	PERF.	FIRING	ENGR.	SCHED.	UNSCHEDULED
	FROM SHEET 2			800.8		244.4		290.6		265.8					
8/23	MAINT/DURABILITY	KNOX	46.1	846.9	14.0	258.4	26.9	317.5	5.2	271.0					ITR TO170, 172, 173, 175, 179
8/24	" "	"	60.2	907.1	13.5	271.9	14.1	331.6	32.6	303.6					ITR TO183, 185, 186, 189
8/25	" "	"	60.5	967.6	18.1	290.0	14.0	345.6	28.4	332.0					ITR TO190 THRU 196
8/26	" "	"	35.5	1003.1	4.0	294.0	3.5	349.1	28.0	360.0					ITR TO197, 201
8/30	" "	"	1.5	1004.6	1.5	295.5	0	349.1	0	360.0					
8/31	" "	"	97.8	1102.4	0	295.5	74.4	423.5	23.4	383.4		28-HEAT 26-TPDS			ITR TO222, 223
9/2	" "	"	79.0	1181.4	16.9	312.4	12.1	435.6	50.0	433.4					ITR TO240, 241, 244 ITR TO230, 232, 233, 238
9/6	" "	"	40.4	1221.8	16.0	328.4	6.8	442.4	17.6	451.0					ITR TO247, 0248, 0249
9/7	" "	"	48.5	1270.3	22.0	350.4	15.0	457.4	11.5	462.5					ITR TO251, 0252, 0253
9/8	" "	"	44.9	1315.2	20.6	371.0	6.4	463.8	17.9	480.4					ITR TO264, 265, 266
9/9	" "	"	115.0	1430.2	15.0	386.0	30.9	494.7	69.1	549.5					ITR TO269, 270, 271, 272
9/10	" "	"	7.3	1437.5	3.0	389.0	4.3	499.0	0	549.5					ITR TO274 THRU 280
9/12	" "	"	81.6	1519.1	38.3	427.3	43.3	542.3	0	549.5					ITR TO282, 283
9/13	MAINT	"	0.5	1519.6	0.5	427.8	0	542.3	0	549.5					ITR TO289 THRU 299
9/14	BAUM RANGE	"	16.0	1535.6	16.0	443.8	0	542.3	0	549.5					
9/15		"	0.3	1535.9	0.3	444.1	0	542.3	0	549.5					ITR TO 306
9/16-9/20	SPEC CHECKS	"	8.1	1544.0	8.1	452.2	0	542.3	0	549.5	SPEC CHECK				

TABLE 5-6

DURABILITY TEST LOG

PROGRAM PQT-C

TANK MODEL PQ-3 S/N 7415

DATE	REMARKS	LOCATION	MILEAGE								ASSOCIATE TESTS			MAINTENANCE	
			TOTAL		PAVED		SECONDARY		CROSS-COUNTRY						
			DAILY	ACCUM.	DAILY	ACCUM.	DAILY	ACCUM.	DAILY	ACCUM.	PERF.	FIRING	ENGR.	SCHED.	UNSCHEDULED
7/20	PROOF FIRING	KNOX	14.5	14.5	6.0	6.0	8.5	8.5				3-HEAT			ITR To 19, 20, 21, 25
7/21	ZEROING	"	15.0	29.5	6.0	12.0	9.0	17.5				14-HEAT			ITR To 26
7/22	MAINT.	"	.3	29.8	.3	12.3	0	17.5							
7/23	MAINT / DURABILITY	"	35.7	65.5	14.0	26.3	7.0	24.5	14.7	14.7					
7/25	ZERO / DURABILITY	"	48.0	113.2	40.0	66.3	8.0	32.5	0	14.7		7-HEAT 11-TPDS			ITR To 36, 37, 38
7/26	MAINT / DURABILITY	"	73.4	186.9	20.0	86.3	24.3	56.8	29.1	43.8					
7/27	FIRING / DURABILITY	"	69.5	256.4	23.3	109.6	42.0	98.8	4.2	48.0		24-HEAT 23-TPDS			ITR To 40, 41
7/28	MAINT / DURABILITY	"	54.9	311.3	21.0	130.6	10.5	109.3	23.4	71.4					ITR To 45, 48, 51
7/29	" "	"	42.0	353.3	7.0	137.6	18.0	127.3	17.0	88.4					
7/30	" "	"	86.4	439.7	14.0	151.6	7.0	134.3	65.4	153.8					
8/1	" "	"	13.9	453.6	7.9	159.8	6.0	140.3	0	153.8					ITR To 57, 58
8/2	FIRING / MAINT / DURA	"	65.9	519.5	21.0	180.5	44.9	185.2	0	153.8		24 HEAT			
8/3	" " "	"	33.6	553.1	11.0	191.5	22.6	207.8	0	153.8					ITR To 70, 71, 76
8/4	" " "	"	13.8	566.9	7.0	198.5	6.8	214.6	0	153.8		17 HEAT 40 TPDS			ITR To 69, 77
8/5	" " "	"	50.0	616.9	17.0	215.5	11.0	225.6	22.0	175.8					ITR To 83, 84
8/8	SURVEILLANCE / MAINT	"	13.7	630.6	4.8	219.5	6.3	231.9	3.4	179.2	SURVEIL				ITR To 90, 91, 96, 97
8/9	" "	"	13.2	643.8	6.0	225.5	7.2	239.1	0	179.2	SURVEIL				
8/10	Ⓠ SERVICE	"		643.8		225.5		239.1		179.2				Q-SERVICE	ITR To 104, 105, 106, 110, 111, ITR To 126, 128
8/15	SURVEILLANCE / DURA	"	41.2	685.0	8.9	234.4	7.0	246.1	25.3	204.5	SURVEIL.	12 HEAT			
8/16	FIRING / DURABILITY	"	50.7	735.7	7.0	241.4	23.7	269.8	20.0	224.5		25 HEAT			ITR To 132, 133
8/17	" "	"	41.0	776.7	0	241.4	41.0	310.8	0	224.5		8 HEAT 3 TPDS			
8/18	" "	"	56.3	833.0	8.0	249.4	6.1	316.9	42.2	266.7					
8/19	MAINT / FIRING	"	13.8	846.8	7.0	256.4	6.8	323.7	0	266.7		26 HEAT 22 TPDS			ITR To 167, 168, 169 ITR To 193 TARU 150
8/22	MAINT / DURABILITY	"	43.3	890.1	7.0	263.4	7.0	330.7	29.3	296.0					ITR To 163
8/23	" "	"	88.4	978.5	14.0	277.4	40.0	370.7	34.4	330.4					ITR To 169, 176, 177, 178
8/24	" "	"	67.8	1046.3	13.5	290.9	30.1	400.8	24.2	354.6					ITR To 184

TABLE 5-6 (CONT)
DURABILITY TEST LOG

PROGRAM PQT-S
TANK MODEL PQ-3 S/N 7415

DATE	REMARKS	LOCATION	MILEAGE								ASSOCIATE TESTS			MAINTENANCE	
			TOTAL		PAVED		SECONDARY		CROSS-COUNTRY						
			DAILY	ACCUM.	DAILY	ACCUM.	DAILY	ACCUM.	DAILY	ACCUM.	PERF.	FIRING	ENGR.	SCHED.	UNSCHEDULED
	FROM SHEET 1			1046.3		290.9		400.8		354.6					
8/25	MAINT/DURABILITY	KNOX	64.3	1110.6	17.1	308.0	13.9	414.7	33.3	387.9					ITR TO198, 199, 200
8/26	" "	"	0	1110.6	0	308.0	0	414.7	0	387.9					ITR TO202 THRU 208
8/29	FIRING/DURABILITY	"	56.3	1166.9	16.0	324.0	21.2	435.9	19.1	407.0		39 TPDS			ITR TO214, 215
8/30	" "	"	32.2	1199.1	0	324.0	32.2	468.1	0	407.0		24 HEAT			ITR TO218, 219, 228, 229
8/31	DURABILITY	"	115.1	1314.2	0	324.0	79.7	547.8	35.4	442.4					ITR TO224 THRU 226
9/1	"	"	52.9	1367.1	0	324.0	0	547.8	52.9	495.3					ITR TO227, 230, 239
9/2	"	"	73.1	1440.2	4.2	328.2	23.9	571.7	45.0	540.3					ITR TO 243, 242,
9/6	"	"	59.2	1499.4	59.2	387.4	0	571.7	0	540.3					ITR TO 246
9/7	VALIDATION	"	.4	1499.8	.4	387.8	0	571.7	0	540.3					ITR TO 264, 262 ITR TO 257, 255, 258, 259
9/8		"	7.1	1506.9	3.0	390.8	4.1	575.8	0	540.3		1 HEAT			
9/12		"	6.8	1513.7	2.9	393.7	3.9	579.7	0	540.3		18 HEAT 2 TPDS			
9/13	MAINT	"	.1	1513.8	0.1	393.8	0	579.7	0	540.3					ITR 0295 THRU 0300
9/14	BAUM RANGE	"	16.0	1529.8	16.0	409.8	0	579.7	0	540.3					ITR TO302, 303
9/15		"	0.2	1530.0	0.2	410.0	0	579.7	0	540.3					
9/16-9/20	SPEC CHECK	"	7.2	1537.2	7.2	417.2	0	579.7	0	540.3	SPEC CHECK				

Component Code * PRETEST ITR

A1 Standard M60A1 Part
P Product Improvement Part
X Experimental Part

SUMMARY REPORT
INCIDENT OF MALFUNCTION

PQ-1 TANK, S/N 7403

TABLE 5-7

Item No.	Component Code	Component Nomenclature	Incident	Action Taken	ITR Date	ITR No.	Test Miles
* 1	P	TTS power converter	Power converter malf. on bite	Replaced PC board		T0001	0
* 2	P	LRF	Mal. 3 indicated - intermittent	Interchanged common EV PC boards with spare elect. unit		T0002	0
* 3	P	Computer system	Bite test light for gun on all of time, due to bent pins on computer unit	Straightened pins and installed same unit		T0003	0
* 4	P	TTS electrical cable - converter to periscope	Cable routing and configuration put stress on connector when fastened	Re-adjusted clamps and routing of cable		T0005	0
* 5	A1	Hydraulic power pack	Oil can be heard draining back into the reservoir	Maintenance action deferred		T0011	0
* 6	A1	Commander's turret and gun control	Commander's override is intermittent	Maintenance action deferred		T0013	0
7	A1	Roadwheel hub bolt	Number 2 left bolt missing	Replaced missing bolt	7/19	T0016	14.1
8	A1	Control valve assembly	Hydraulic oil leak at spool "O" ring	Maintenance action deferred	7/19	T0017	14.1
9	P	TTS day sight boresight knobs	Boresight knob design and location are not designed for human capabilities	None	7/20	T0019	0
10	P	Manual traverse handle	Manual traverse handle barely clears TTS periscope body	None	7/20	T0020	0

Component Code

A1 Standard M60A1 Part
P Product Improvement Part
X Experimental Part

SUMMARY REPORT

INCIDENT OF MALFUNCTION

PQ-1 TANK, S/N 7403

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
11	P	Grenade launcher control box mounting plate	The plate has a sharp corner making it a safety hazard	None	7/20	T0021	0
12	P	Shroud retainer rubber	The forward thermo shroud rubber retainer extruding from underneath shroud	None	7/20	T0022	28.1
13	P	Clamp, thermo shroud	The spring retainer on the front section of the thermo shroud failed at spot welds during gun fire	Secured clamp handle with gun tape	7/20	T0023	28.1
14	P	TTS daylight periscope	Approximately 0.3 parallax in the daylight sight	None	7/20	T0025 -S1	28.1
15	P	TTS periscope assembly	Periscope will not switch between narrow and wide field of view	Pivot pin for field of view had shifted blocking the focus mechanism	7/21	T0027	42.1
16	P	Laser rangefinder	Laser rangefinder will not go out of test mode	Maintenance action deferred	7/21	T0028	42.1
17	P	Laser rangefinder	Laser rangefinder will not go out of test mode	Laser rangefinder low voltage and -1600 voltage supplies were replaced	8/1	T0028 -S1	285.2
18	A1	Centerguide	Lost centerguide on right track	Replaced missing centerguide	7/21	T0029	42.1
19	P	TTS periscope head seal	Water leaks down the periscope head during rain	None	7/25	T0036	
20	X	Air cleaner restriction indicator	Right air cleaner indicator in red	Reset and monitor	7/27	T0042	296.7
21	P	TTS commander's sight mount	The removable portion of the ball mount was missing	Item found on turret basket floor and re-installed	7/28	T0043	317.7

Component Code

A1 Standard M60A1 Part
P Product Improvement Part
X Experimental Part

SUMMARY REPORT

INCIDENT OF MALFUNCTION

PQ-1 TANK, S/N 7403

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
22	P	TTS commander's sight	Moisture in the viewer lens of the commander's sight	NVL purged the sight, moisture would not come out. Unit had to be disassembled and dryed.	7/28	T0046	317.7
23	P	TTS commander's sight	Fuzzy focus	Image intensifier tube was found to be loose and NVL tightened it.	7/28	T0047	296.7
24	A1	Tachometer	Indicator needle fell off	Maintenance action deferred	7/28	T0049	326.3
25	P	TTS periscope head	Focus control jammed	Item repaired by NVL	7/28	T0050	326.3
26	P	TTS system	TTS maintenance problems	None	7/29	T0051	
27	A1	Bore evacuator assembly	Rear retainer bolt failed	Maintenance action deferred	8/1	T0055	457.9
28	A1	Bore evacuator assembly	Rear retainer bolt failed	Removed failed bolt and installed new one	8/10	T0055 SI	751.7
29	A1	Centerguide	Two bent and one broken centerguide on right track	Replaced the components	8/1	T0056	457.9
30	A1	Output unit	Erratic performance due to binding cable	Rerouted cable	8/2	T0060	530.4
31	A1	Output unit	See above	Further information	8/2	T0060 -S1	530.4
32	A1	Slave receptacle cable	Slave receptacle cable shorted out against the personnel heater	Wrapped cable with tape	8/3	T0064	611.4
33	P	TTS periscope head	Moisture inside the periscope	NVL purged the system	8/3	T0065	611.4

Component Code

A1 Standard M60A1 Part
P Product Improvement Part
X Experimental Part

SUMMARY REPORT
INCIDENT OF MALFUNCTION

PQ-1 TANK, S/N 7403

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
34	A1	Centerguide	Centerguide missing on the left track	Replaced missing centerguide	8/4	T0073	667.4
35	A1	Centerguide	Centerguide missing on the left track	Replaced missing centerguide	8/5	T0078	723.5
36	A1	Wedge and screw	Six wedge bolts loose on the left track	Retightened loosened bolts	8/5	T0079	723.5
37	X	Air restriction indicator	Indicator trips periodically	Reset and monitor	8/5	T0080	723.5
38	P	TTS reticle illumination system	Reticle illumination must be adjusted for each sight	None	8/5	T0088	723.5
39	P	TTS ballistic shield handle	Ballistic shield jams such that the handle will not open it	None	8/8	T0089	737.3
40	A1	Centerguide	Centerguide missing on right track	Replaced missing centerguide	8/8	T0093	737.3
41	A1	Wedge-bolts	Four loose wedge-bolts on the left track	Retightened the loose wedge-bolts	8/8	T0094	737.3
42	P	T142 track pad	Lost rubber portion of track pad on the right track	Replaced track pad	8/10	T0098	751.6

Component Code

A1 Standard M60A1 Part
P Product Improvement Part
X Experimental Part

SUMMARY REPORT

INCIDENT OF MALFUNCTION

PQ-1 TANK, S/N 7403

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
43	A1	Centerguide	One broken and three bent centerguide on the right track	Replaced damaged centerguide	8/10	T0099	751.6
44	P	TTS periscope head	Both the 1X and 8X reticle bulbs were defective	Replaced defective bulbs	8/11	T0107	751.6
45	P	Rubber sleeve: front thermal shroud	Rubber sleeve torn	Replaced torn sleeve	8/11	T0109	751.6
46	A1	Screw-telescope wedge	Wedge block retaining screw failed	Replaced screw	8/12	T0114	752
47	P	TTS periscope head	1X and 8X reticle bulb failures	Dropped reticle bulb voltage from 18 VDC to 14 VDC	8/13	T0115	752
48	A1	Centerguide	Centerguide on the left track missing	Replaced missing centerguide	8/16	T0129	752
49	A1	Blower: air cleaner	Left inboard blower inoperative	Item to be replaced when procured	8/16	T0130	859.2
50	A1	Screw: telescope wedge	Wedge screw failed	Replaced wedge screw	8/16	T0134	859.2
51	P	TTS daylight sight	Moisture inside the TTS daylight sight	Purged unit with dry nitrogen	8/17	T0138	944.6
52	A1	Roadwheel wearplate	Number 3 left inside wearplate missing	Replaced missing wearplate	8/18	T0141	968.9
53	P	TTS periscope daylight reticle	Daylight reticle shifted .5 mil azimuth right and .5 mil elevation down	None	8/18	T0142	968.9
54	A1	Centerguide	Centerguide missing from left track	Replaced missing centerguide	8/19	T0156	975.9

Component Code

A1 Standard M60A1 Part
P Product Improvement Part
X Experimental Part

SUMMARY REPORT

INCIDENT OF MALFUNCTION

PQ-1 TANK, S/N 7403

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
55	P	T142 track	Broken track pin on left track	Replace track shoe assembly	8/19	T0157	975.9
56	P	TTS ballistic shield spring	Spring deformed taking a permanent set	TI and NVL replaced the spring	8/20	T0158	982.8
57	A1	Roadwheel wearplate	#4 and #6 left outboard roadwheel wearplates missing	Replaced wearplates	8/19	T0160	975.9
58	A1	Centerguide	Missing a centerguide on the left track and a broken centerguide on the right track	Replaced centerguides	8/23	T0161	1020.9
59	P	T142 track	Right track thrown to the inside while a left turn on a slight inclined in soupy mud	Track was cut with a torch and re-installed at the armor board	8/23	T0162	1020.9
60	P	XM21 computer	LRF superelevation output lower than manual setting	None	8/22	T0165	996.7
61	P	LRF/EU	Same as above	Replaced A6 PC board in electronics unit	8/29	T0165 -S1	1158.1
62	P	Ballistic door opening mech - J rod	During spring replacement it was noted that the J rod was bent	Replaced the J rod	8/20	T0166	982.8
63	P	TTS periscope head	Field of view shifts up when switching from wide to narrow field	No action taken	8/22	T0171	996.7
64	A1	Turret traverse gearbox	Turret traverses without depressing the palm switches	Magnetic brake failure, replaced gear-box	8/24	T0174	1020.9
65	A1	Turret traverse gearbox		Original gearbox repaired and re-installed	9/15	T0174 -S1	1549.9

Component Code

A1 Standard M60A1 Part
P Product Improvement Part
X Experimental Part

SUMMARY REPORT

INCIDENT OF MALFUNCTION

PQ-1 TANK, S/N 7403

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
66	A1	Centerguide	One broken and one bent centerguide on right track	Replaced centerguides	8/24	T0180	996.7
67	P	T142 track pad	Track pads worn done to metal on both tracks	Replaced all track pads	8/24	T0181	996.7
68	X	Straight adapter	Transmission oil leak at adapters on the right side of the transmission	Both fittings were retightened	8/24	T0182	1020.9
69	A1	Wedge-bolts	Seven loose wedge bolts on right track and three on left track	All loose components were tightened	8/25	T0187	1091.7
70	A1	Centerguide	Centerguide missing on right track	Replaced missing centerguide	8/25	T0188	1091.7
71	A1	Deck clearance valve	Deck clearance inoperative	Secured loose electrical connection	8/25	T0209	1091.7
72	A1	Centerguide	Centerguide missing from the left track	Replaced centerguide	8/26	T0211	1117.2
73	A1	Centerguide	Centerguide missing from the left track	Replaced centerguide	8/29	T0212	1235.0
74	P	T142 track shoe assy	A broken binocular on the right track	Replaced track shoe assembly	8/29	T0213	1281.7
75	A1	Centerguide	Centerguide missing from right track	Replaced lost centerguide	8/30	T0216	1322.9
76	P	Diesel engine	Oil pressure gauge in the red - unable to restart engine after shutdown	Replaced diesel engine	8/30	T0217	1343.6
77	P	TTS periscope head	Unable to keep the reticle and target in proper focus	Notified NVL	8/31	T0221	1343.6

Component Code

A1 Standard M60A1 Part
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SUMMARY REPORT

INCIDENT OF MALFUNCTION

PQ-1 TANK, S/N 7403

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
78	P	Wind sensor most protective cover	Wind sensor protective cover missing	No replacement parts available	9/1	T0230	1405
79	A1	Transmission	Oil observed dripping from access plate above the left band adjustment	Tightened loose bolts	9/2	T0231	1405
80	A1	Power pack	Seven fuel injectors leaking and oil leaking from trans oil cooler tube	Replaced fuel injectors and oil cooler tube	10/17	T0231 -S1	1550
81	P	Laser rangefinder	Laser rangefinder will not lase past 1200M	Maintenance action deferred	9/2	T0235	1405
82	P	Laser rangefinder	Same as above	Further information	9/2	T0235 -S1	1405
83	A1	Support roller wearplate	Number 2 right support roller outer wearplate loose due to missing and failed bolts	Replaced support roller wearplate	9/2	T0236	1405
84	A1	Centerguide	Missing centerguide on the right track	Replaced missing centerguide	9/2	T0237	1405
85	A1	Hull brake fluid line and personnel heater line	Lines damaged by "bang" shield while the turret was traversing	Bled brake pressure line and shut off fuel to the heater	9/6	T0245	1433.4
86	P	TTS periscope head	Gunner's display 25% blanked out on left side	Failure in the scan interface board - board replaced	9/7	T0250	1433.4
87	P	TTS periscope head	1X reticle bulk burned out	Replaced bulb	9/7	T0256	1433.4
88	P	TTS periscope head	Excessive cool down time due to cryogenic cooler failure	Item to be replaced as soon as parts are made available	9/8	T0257	1517.6

Component Code

A1 Standard M60A1 Part
P Product Improvement Part
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SUMMARY REPORT

INCIDENT OF MALFUNCTION

PQ-1 TANK, S/N 7403

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
89	A1	Networks box assembly	Power pack blower motor circuit breaker switch broken	Replaced networks box assembly	9/26	T0260	1158.1
90	P	Laser rangefinder and electronics unit	LRF/EU failure due to water in EU electrical connectors causing a high voltage arc when turned on	Unit sent back to CWDD for repairs	9/8	T0263	1517.8
91	A1	Coupling, clamp grooved, shroud tube	Difficulty in tightening the clamp nut	Replaced with a new one	9/9	T0268	1518.5
92	P	Laser rangefinder and electronics unit	Laser will not lase over 1200M	None at this time	9/12	T0281	1525.5
93	P	TTS periscope head	Head mirror in the periscope slipped	Readjusted to center boresight knob travel	9/13	T0301	1532.5
94	P	Air cleaner gasket	Water found in right air cleaner housing	Filters blown clean and water wiped up	9/14	T0304	1549.4
95	A1	Batteries	Batteries were found to be marginal for the EMC/electrical transient tests	Replaced batteries	9/15	T0305	1549.9

Component Code

A1 Standard M60A1 Part
P Product Improvement Part
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* PRETEST ITR

SUMMARY REPORT

INCIDENT OF MALFUNCTION

PQ-2 TANK, S/N 7406

TABLE 5-8

	Item No.	Component Code	Component Nomenclature	Incident	Action Taken	ITR Date	ITR No.	Test Miles
*	1	A1	Superelevation drive cable	Output unit would not operate	Loosened nut connecting cable to output unit		T0004	0
*	2	P	TTS electrical cable - converter to periscope	Cable routing and configuration put stress on connector when fastened	Re-adjusted clamps and routing of cable		T0005	0
*	3	P	TTS periscope head	Focus knob jammed internal binding of focus mechanism	Knob came free as head was removed		T0006	0
*	4	A1	Deck clearance system	Deck clearance malfunction	The electrical to the deck clearance valve was repaired		T0007	0
*	5	P	TTS periscope body	Bite test indicated bad periscope head	NVL replaced the power supply PC board		T0009	0
	6	A1	Power pack	Transmission oil leak	Maintenance action deferred		T0010	0
*	7	A1	Power pack	Transmission oil leak found to be at the right output shaft	Replaced transmission		T0010 -S1	0
*	8	A1	Hydraulic power reservoir	Oil can be heard draining back into the reservoir	Maintenance action deferred		T0011	0
*	9	A1	Stabilization system	Turret jumps 10 to 15 mils when stab is engaged	Maintenance action deferred		T0012	0
*	10	P	Computer - lead solution	Computer head solutions in stab moving mode were not in spec, but were repeatable. Range switch may have been left in manual mode.	Computer solutions to be repeated at a later date		T0014	0
	11	A1	End connector	Lost end connector, wedge and bolt left track	Replaced missing components	7/19	T0015	14.1

Component Code

A1 Standard M60A1 Part
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SUMMARY REPORT

INCIDENT OF MALFUNCTION

PQ-2 TANK, S/N 7406

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
12	P	TTS daylight periscope	Approximately 0.3 mil parallax in day sight	None - laboratory adjustment	7/19	T0018	14.1
13	P	TTS day sight boresight knobs	Boresight knob design and location are not designed for human capabilities	None	7/20	T0019	0
14	P	Manual traverse handle	Manual traverse handle barely clears TTS periscope body	None	7/20	T0020	0
15	P	Grenade launcher control box mounting plate	The plate has a sharp corner making it a safety hazard	None	7/20	T0021	0
16	P	Laser rangefinder	Malfunction 3 and LRF would not come out of the test mode. Later it regained normal operation	Maintenance action deferred	7/20	T0024	28.0
17	A1	Centerguide	Lost centerguide on right track	Replaced missing centerguide	7/21	T0030	88.2
18	A1	Valve, core	Loss of accumulator precharge pressure	Replaced the shrader valve	7/22	T0031	119.4
19	A1	Adapter, tachometer	Tachometer inoperative	Replaced tachometer adapter	7/22	T0032	119.4
20	A1	Centerguide	Lost centerguide on left track	Replaced missing centerguide	7/23	T0033	119.4
21	A1	Wedge bolts	Loose wedge bolts	Retorqued over comp idler wheel	7/25	T0034	165.1
22	A1	Wedge bolts	There are five missing wedge bolts on the left track	Replaced missing components	7/23	T0035	157.9
23	P	TTS periscope head seal	Water leaks down the periscope head during rain	None	7/25	T0036	

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A1 Standard M60A1 Part
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Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
24	P	End connector hardened	End connector worn inside	Replaced end connector	7/27	T0039	289.5
25	A1	Track block T142	Track pin failed at centerguide on right side	Replaced track block	7/27	T0044	289.5
26	P	TTS system	TTS maintenance problems	None	7/29	T0051	
27	A1	Brake system	Brake system did not function properly on a rebuilt transmission	Brake system adjusted according to the manual	8/1	T0052	347.3
28	A1	Transmission	Transmission oil leak	Replaced transmission with a rebuilt transmission that developed an oil leak, then swapped power packs from another vehicle	8/1	T0053	325.4
29	A1	Transmission	Transmission oil leak	Transmission left output shaft flange cracked - replaced flange	8/30	T0053 -S1	1002.8
30	X	Final drive vent line	Final drive vent line shrunk due to engine exhaust heat	Maintenance action deferred	8/1	T0054	324.2
31	X	Final drive vent line	See above	Replaced damaged vent line	9/27	T0054 -S1	
32	A1	T142 track	Three broken track pins on the left track	Replaced failed components	8/2	T0059	354.4
33	A1	Indicator liquid quantity	Fuel gauges inoperative	Maintenance action deferred	8/2	T0061	354.4
34	P	Laser rangefinder	Malfunction 3	Replaced laser rangefinder	8/2	T0062	354.4
35	A1	Angle, fender reinforcement: L	Fender reinforcement failed forward of fender	Maintenance action deferred	8/3	T0063	368.8

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A1 Standard M60A1 Part
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SUMMARY REPORT
INCIDENT OF MALFUNCTION
PQ-2 TANK, S/N 7406

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
36	A1	Angle, fender reinforcement: L	See above	Replaced failed component	8/10	T0063 -S1	567.7
37	P	Wind sensor	Large azimuth deviations occurred during gun firing	Wind sensor pin pushed in breaking electrical contact	8/3	T0066	368.8
38	P	TTS periscope head	No "black-hot" display on thermal channel	Maintenance action deferred	8/3	T0067	368.8
39	A1	Superelevation actuator cable	Superelevation actuator cable lays on manual turret traverse shaft	None	8/3	T0068	409.7
40	P	Computer, gunners control unit	Common zero azimuth knob jammed	Maintenance action deferred	8/3	T0072	409.7
41	P	Computer, gunner's control unit	Common zero azimuth knob is now free	None	8/5	T0072 -S1	409.7
42	A1	T142 track shoe	There are 4 broken pins on the left track and one on the right track	Replaced the failed components	8/4	T0074	409.6
43	A1	Screw	Left air cleaner rear inside and outside retaining bolts failed	Maintenance action deferred	8/4	T0075	409.6
44	A1	Centerguide	Centerguide missing from the right track	Replaced missing centerguide	8/6	T0081	540.1
45	A1	Nut assembly: roadwheel	There are five loose roadwheel nuts on number 1 left roadwheel	Nuts were retightened	8/6	T0082	540.1
46	A1	Nut assembly: roadwheel	There are three roadwheel nuts loose on number one left roadwheel	Retightened the nuts	8/10	T0082 -S1	567.7

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A1 Standard M60A1 Part
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SUMMARY REPORT

INCIDENT OF MALFUNCTION

PQ-2 TANK, S/N 7406

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
47	A1	Steering control	Steering control linkage binding	Maintenance action deferred since power pack removal is required	8/6	T0085	540.1
48	A1	Steering control	Steering control linkage binding	The threaded portion of the shield: rear rod was bent	8/10	T0085 -S1	567.7
49	X	Air restriction indicators	Air restriction indicators locked in "red"	Air cleaner filters were cleaned again and the air restriction indicators were reset	8/5	T0086	540.1
50	P	Laser rangefinder	Malfunction 3 when ranging	None	8/5	T0087	540.1
51	P	Laser rangefinder	Malfunction 3 when ranging	A safety jumper cable to prohibit lazing was inadvertently left connected	8/22	T0087 -S1	800
52	P	TTS reticle illumination system	Reticle illumination must be adjusted for each sight	None	8/5	T0088	800
53	A1	Wedge/Bolts	Five missing wedge-bolts	Replaced missing wedge-bolts	8/8	T0092	254.0
54	A1	Parking brake	Parking brake would not release	Released parking brakes manually	8/8	T0095	554.0
55	A1	Core, flexible shaft assembly	Tachometer core failed	Replaced tachometer core	8/10	T0100	567.6
56	A1	Wearplate	One half of the #6 left inside wear-plate missing	Replaced missing components	8/10	T0101	567.7
57	A1	Wedge bolts	Two wedge bolts missing on right track	Replaced missing components	8/10	T0102	567.7
58	P	T142 track pad	Track pads worn down to metal track section	No	8/10	T0103	567.7

Component Code

A1 Standard M60A1 Part
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SUMMARY REPORT
INCIDENT OF MALFUNCTION

PQ-2 TANK, S/N 7406

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
59	P	T142 track pad	Track pads worn	Replaced all track pads on both tracks	8/13	T0103 -S1	568.6
60	P	TTS periscope head	1X and BLK HOT bulbs defective	Replaced defective bulbs	8/11	T0108	567.6
61	A1	Blower, air filter	Right air cleaner inboard blower inoperative	Replaced failed unit	8/12	T0112	568.6
62	A1	105mm gun tube	4 inch crack forward of the bore evacuator	Replaced gun tube	8/12	T0113	568.6
63	A1	Screw - telescope wedge	Telescope wedge block retaining screw missing	Replaced missing screw	8/13	T0116	575.6
64	A1	Control box, gunner's switch box	Turret power/elevation switch inoperative	Maintenance action deferred due to lack of parts	8/15	T0117	591.7
65	A1	Lamp: Azimuth indicator	All four azimuth indicator bulbs burned out	Maintenance action deferred due to lack of parts	8/12	T0118	568.6
66	A1	Screw: roadwheel wearplate	Number one right outside roadwheel wearplate bolt missing and number six right inside roadwheel wearplate bolt sheared	Replaced failed components	8/12	T0119	568.6
67	A1	Wedge-bolt	Missing one wedge-bolt on left track	Replaced missing components	8/12	T0120	568.6
68	P	Cant unit	Cant unit seal leaks	Maintenance action deferred due to lack of parts	8/12	T0121	568.6
69	A1	Centerguide	Approximately 60 centerguides found loose on the right track	Retightened centerguides	8/13	T0122	568.6

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A1 Standard M60A1 Part
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INCIDENT OF MALFUNCTION

PQ-2 TANK, S/N 7406

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
70	A1	Distribution box	The utility power outlet does not operate on the turret vent blower box	Replaced assembly	8/13	T0123	568.6
71	P	TTS periscope head	High voltage power supply for the I^2 tube failed	Replaced the power supply	8/15	T0124	591.6
72	P	TTS periscope head	1X and 8X reticle bulb failures	Reticle bulk voltage lowered from 18 VDC to 14 VDC.	8/11	T0125	568.1
73	A1	Centerguide	Centerguide missing on right track	Replaced missing centerguide	8/16	T0131	672.2
74	P	Thermal shroud: can assembly	Can assembly slips forward	Repositioned can assembly	8/16	T0132	692.4
75	A1	Wedge-bolts	Four loose wedge-bolts	Retightened wedge-bolts	8/16	T0135	672.2
76	A1	Wedge-telescope	Telescope wedge missing	Replaced wedge	8/16	T0136	672.2
77	P	Thermal shroud can assembly	Can assembly slips forward	Repositioned can assembly	8/16	T0137	672.2
78	P	T142 track	Track separated while running durability mileage	Replaced four track shoes since there were six (6) broken pins in a row	8/17	T0139	712.4
79	P	TTS periscope head	Contrast control failed	Replaced contrast control	8/18	T0140	727.3
80	A1	Centerguide	One missing centerguide on right track	Replaced missing centerguide	8/19	T0151	727.3
81	A1	Air cleaner bolt	Left air cleaner rear center bolt and right air cleaner rear inside bolt failed.	Replaced failed bolts	8/19	T0152	727.3

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A1 Standard M60A1 Part
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PQ-2 TANK, S/N 7406

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
82	A1	Wedge-bolt	Wedge-bolt missing on the inside of the left track	Replaced missing wedge-bolt	8/19	T0153	727.3
83	A1	Fender support: No. 2 left	Fender support failed	Welded fender support at failed areas	8/19	T0154	727.3
84	A1	Fender support: No. 2 left	Fender support failed at welded areas	Item to be replaced when it becomes available	9/1	T0154 -S1	1100.6
85	A1	Commander's intercom box bracket	Brackets left two tabs failed at weld	Maintenance action deferred	8/19	T0155	727.3
86	P	TTS ballistic shield spring	Spring deformed taking a permanent set	TI and NVL replaced the spring	8/20	T0159	769.3
87	P	TTS ballistic shield assembly	Shoulder bolt fastening ballistic door failed	Replaced bolt	8/20	T0169	769.3
88	A1	Accumulator pressure switch	Hydraulic power pack motor failed to operate	Accumulator pressure switch was sticking and it was replaced	8/23	T0170	813.6
89	P	TTS periscope head	Field of view shifts up when switching from wide to narrow field of view	No action taken	8/23	T0172	813.6
90	P	TTS periscope head	Moisture observed in gunner's display	Purged gunner's display	8/23	T0173	813.9
91	P	TTS periscope head	See above	Leakage occurs at the RPU electrical connector and no repair is planned	8/23	T0173 -S1	813.9
92	A1	Support roller wearplate	Lost number 2 right inboard support roller wearplate	Replaced missing components	8/23	T0175	813.9

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A1 Standard M60A1 Part
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SUMMARY REPORT
INCIDENT OF MALFUNCTION
PQ-2 TANK, S/N 7406

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
93	P	T142 track pad	Lost one track pad from right track	Replaced track pad	8/23	T0179	813.9
94	A1	Centerguide and wedge bolts	Two loose wedge bolts on the right track and two loose centerguides on the left track and five on the right track	Retightened loose components	8/24	T0183	865.0
95	P	T142 track shoe	Right track pin failed at both end connector positions	Replaced track shoe	8/23	T0185	846.1
96	P	TTS periscope head	Something obscuring the gunner's sight	Notified NVL	8/23	T0186	846.1
97	P	XM21 computer	Manual range knob fell off	Replaced knob	8/24	T0189	906.3
98	A1	Roadwheel wearplate	Number 4 right inside wearplate damaged	Replaced wearplate	8/25	T0190	965.8
99	A1	Roadwheel wearplate screws	There are three missing retaining screws on #5 inside wearplate on the right side	Replaced missing screws	8/25	T0191	965.8
100	A1	Handle assembly	Left hull ammo lock handle bent	Straightened the ammo rack handle	8/25	T0192	965.8
101	A1	Air cleaner retaining screws	One air cleaner retaining screw failed on the right air cleaner (outside rear position) and two on left air cleaner (inside and middle rear position)	Maintenance action deferred	8/25	T0193	965.8
102	A1	Fender extension bolts	There are three right air cleaner fender extension bolts missing	Maintenance action deferred	8/25	T0194	965.8

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A1 Standard M60A1 Part
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Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
103	P	T142 track	Broken pin on left track	Replaced track shoe assembly	8/25	T0195	965.8
104	A1	Centerguide	One centerguide missing on the left track	Replaced missing centerguide	8/25	T0196	965.8
105	P	TTS periscope head	Reticle lamp out in unity sight	Maintenance action deferred	8/26	T0197	965.8
106	P	Diesel engine	Block cracked on both sides	Installed original engine transmission	8/26	T0201	1001.3
107	A1	Roadwheel wearplate	Number five inside roadwheel wear-plate missing	Replaced wearplate	8/30	T0218	1047.1
108	A1	Wedge bolt	Three loose wedge bolts on the left track	Retightened wedge bolts	8/31	T0222	1047.1
109	P	T142 track shoe assembly	Broken pin on right track	Replaced the track shoe assembly	8/31	T0223	1100.6
110	P	Wind sensor most protective cover	Wind sensor protective cover missing	No replacement parts available	9/1	T0230	1100.6
111	A1	Commander's intercom box bracket	Bracket failed at all four welds	Maintenance action deferred	9/1	T0232	1100.6
112	A1	Commander's intercom box bracket	See above	Rewelded bracket	10/4	T0232 -S1	1535.4
113	P	Laser rangefinder	Unable to lase to 1200M	Maintenance action deferred	9/1	T0233	1101.1
114	P	Laser rangefinder	See above	Replaced laser rangefinder	9/9	T0233 -S1	1270.3

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Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
115	A1	Vehicular brakes	Brake system bled of air and able to achieve 1100 psi. Later in the day only 300 psi could be achieved	Bled brake system of air again	9/2	T0238	1179.6
116	P	T142 track pad	Four track pads missing	Replaced missing track pads	9/2	T0239	1179.6
117	A1	Wedge-bolts	Three loose wedge-bolts on the left track	Retightened the wedge-bolts	9/2	T0240	1179.6
118	P	T142 track	Track pin broken on the left track	Replaced track shoe	9/2	T0241	1179.6
119	P	T142 track	See above	Further information	9/2	T0241 -S1	1180.1
120	A1	End Connector	Outer end connector missing on left track	Replaced end connector	9/2	T0244	1180.1
121	A1	Screw: link to hub and arm assembly	Screw failed, portion still left in arm assembly - left side	Maintenance action deferred	9/6	T0247	1220
122	A1	Bolt: Air cleaner to outrigger	Right air cleaner rear inside and left air cleaner rear outside failed	Replaced bolts	9/6	T0248	1220
123	A1	Loader's hatch seal	Loader's hatch seal damaged	Maintenance action deferred	9/6	T0249	1220
124	A1	Wedge-bolt	Wedge bolt missing on left track	Replaced missing wedge bolt	9/7	T0251	1268
125	P	Primary fuel filter kit	Loss of engine power	Replaced clogged fuel filters	9/9	T0252	1315.2
126	P	T142 track pad kit	The rubber is missing from two left track pads	Replaced damaged track pads	9/8	T0253	1268

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A1 Standard M60A1 Part
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PQ-2 TANK, S/N 7406

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
127	A1	Filter element: air intake	Air restriction indicators in the red	Cleaned both air cleaners and reset indicators	9/8	T0264	1270.3
128	A1	Wedge bolts	Six loose wedge bolts on the left track	Retorqued bolts	9/8	T0265	1270.3
129	P	XM21 computer	Reticle projector and computer malfunction lights on	None	9/8	T0266	1312.9
130	A1	Wedge bolt	Wedge bolt missing from left track	Replaced missing wedge bolt	9/9	T0269	1427.9
131	P	T142 track	Threw left track to the inside and it came off the sprocket	When the vehicle was towed out of the area the track reset itself	9/9	T0270	1427.9
132	A1	Centerguide	Lost one centerguide from the left track	Replaced missing centerguide	9/9	T0271	1427.9
133	A1	Support roller wearplate	Number 3 inside support roller wearplate damaged	Replaced wearplate	9/9	T0272	1427.9
134	P	T142 track	No bushings were present on either binocular pin or one track section	Replaced track section	9/10	T0274	1435.7
135	A1	Roadwheel wearplate screws	Edge of wearplate separated from number six left inboard roadwheel	Replaced missing bolts	9/10	T0275	1435.7
136	A1	Roadwheel wearplate	Number one left inboard roadwheel is missing both wearplate	Replaced missing wearplates	9/10	T0276	1435.7
137	P	TTS periscope head	Distortion in viewed image	Replaced burned out bulb in the reticle projector, adjusted the afocal and purged the system	9/10	T0277	1435.7
138	P	T142 track pad	Rubber missing on seven track pads	Replaced seven track pads	9/10	T0278	1435.7

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A1 Standard M60A1 Part
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Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
139	P	T142 track	Loose track tension	Adjusted track tension	9/10	T0279	1435.7
140	A1	Adjusting link assembly - left track	Left track adjusting link assembly separated while driving the vehicle	Repaired link assembly with parts made available from another vehicle	9/10	T0280	1435.7
141	P	Ballistic shield gunner's sight TTS	Shield handle detent inoperative leaving ballistic shield in released position - shoulder bolt sheared	Installed new shoulder bolt	9/12	T0282	1435.7
142	P	TTS periscope head	8X reticle bulb burned out	Replaced bulb	9/12	T0283	1435.7
143	A1	Transmission shifting lever	Transmission shifting lever separated at weld	Rewelded shifting lever	9/13	T0284	1519.1
144	A1	Wedge-bolts	Three missing wedge bolts and five loose	Replaced or retightened wedge-bolts as needed	9/13	T0285	1519.1
145	P	T142 track pad	Track pads worn down to the steel grousers	Maintenance action deferred	9/13	T0286	1519.1
146	A1	Centerguide	Missing centerguide on the right track	Replaced missing centerguide	9/13	T0287	1519.1
147	A1	Ballistic arms: 14" and 5"	The 14" and 5" arms were improperly secured thus getting bent by elevating the main gun	Replaced damaged components	9/13	T0288	1519.1
148	A1	Right fender extension	Right fender extension cracked at two bolt hole locations	Replaced the fender extension	9/13	T0289	1519.1
149	A1	Pintle and sleeve assy.	Tow pintle frozen	Greased the tow pintle and worked components loose	9/13	T0290	1519.1

Component Code

A1 Standard M60A1 Part
P Product Improvement Part
X Experimental Part

SUMMARY REPORT

INCIDENT OF MALFUNCTION

PQ-2 TANK, S/N 7406

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
150	A1	Left fender extension	Left fender extension is cracked at the forward bolt location	Replaced the fender extension	9/13	T0291	1519.1
151	A1	#5 left fender support	The left fender support is cracked at previous failure where it was rewelded	Replaced the fender extension	9/13	T0292	1519.1
152	A1	Left fender antisquawk pad	Component damaged in throwing track	Replaced the damaged component	9/13	T0293	1519.1
153	A1	Left rear fender dust shield	Component damaged in throwing track	Replaced the damaged component	9/13	T0294	1519.1
154	P	TTS periscope head	Head mirror slipped in periscope	Maintenance deferred	9/15	T0306	1535.1
155	P	XM21 computer solutions	Computer solutions out of spec	None	9/15	T0307	1535.1

Component Code

A1 Standard M60A1 Part
P Product Improvement Part
X Experimental Part

* PRETEST ITR

SUMMARY REPORT
INCIDENT OF MALFUNCTION

PQ-3 TANK, S/N 7415

TABLE 5-9

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
* 1	P	TTS electrical cable - converter to periscope	Cable routing and configuration put stress on connector when fastened	Re-adjusted clamps and routing of cable		T0005	0
* 2	P	TTS power converter	During checkout prior to vehicle installation there was a power supply malfunction	NVL replaced the power supply PC board		T0008	0
* 3	P	TTS daysight boresight	Boresight knob design and location are not designed for human capabilities	None	7/20	T0019	0
* 4	P	Manual traverse handle	Manual traverse handle barely clears TTS periscope body	None	7/20	T0020	0
* 5	P	Grenade launcher control box mounting plate	The plate has a sharp corner making it a safety hazard	None	7/20	T0021	0
6	P	TTS daylight periscope	Approximately 0.3 mil parallax in daylight sight	None - laboratory adjustment required	7/20	T0025	14.5
7	P	TTS periscope head	TTS head mirror slipped	Re-aligned the head mirror	7/21	T0026	29.5
8	P	TTS periscope head seal	Water leaks down the periscope head during rain	None	7/25	T0036	113.5
9	P	Air cleaner restriction indicator	Left air cleaner indicator in red	Reset and monitor	7/25	T0037	113.5
10	A1	Cupola hand traverse handle pin	Pin securing cupola hand traverse handle failed allowing the handle to come off	Maintenance action deferred	7/25	T0038	113.5

Component Code

A1 Standard M60A1 Part
P Product Improvement Part
X Experimental Part

SUMMARY REPORT
INCIDENT OF MALFUNCTION

PQ-3 TANK, S/N 7415

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
11	A1	Handle assembly 18 rd ammo rack	Two ammo rack handles bent	Maintenance action deferred	7/27	T0040	217.2
12	A1	Cap screw hex head	Screw and mating nut missing from commander's traverse control rod linkage	Replaced missing components	7/27	T0041	217.2
13	P	Air cleaner restriction indicator	Left air cleaner in the red	Reset and monitor	7/28	T0044	224.2
14	P	TTS Commander's sight	Blurred or smeared image on commander's viewer	Optics in the sight shifted and NVL reassembled them	7/28	T0048	224.2
15	P	TTS system	TTS maintenance problems	None	7/29	T0051	
16	P	TTS daylight reticle lamp	Daylight reticle lamp failed	NVL replaced the lamp	8/1	T0057	453.6
17	P	TTS night vehicle lamp	Night reticle lamp failed	NVL replaced the lamp	8/1	T0058	453.6
18	A1	Roadwheel seal assembly	Number 3 roadwheel seal leaking	Replaced the failed seal and repacked bearings	8/4	T0069	566.9
19	A1	Centerguide	Centerguide bent	Replaced centerguide	8/3	T0070	553.1
20	A1	Transmitter, liquid quantity	Fuel sending unit or gauges erratic	Maintenance action deferred	8/3	T0071	553.1
21	P	Laser rangefinder	Range changed during firing (1205m to 2850m) without any operation by the crew	None	8/3	T0076	546.2

Component Code

A1 Standard M60A1 Part
P Product Improvement Part
X Experimental Part

SUMMARY REPORT

INCIDENT OF MALFUNCTION

PQ-3 TANK, S/N 7415

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
22	P	TTS periscope plan	TTS field of view knob moves freely with no change of field of view	NVL repaired a loose locking pin	8/4	T0077	566.9
23	P	TTS ballistic shield	TTS ballistic shield missing	Maintenance action deferred due to unavailability of part	8/5	T0083	616.9
24	X	Air restriction indicators	Both air restriction indicators in red	Cleaned air cleaners only 2 days earlier, cleaned a second time and reset indicators	8/5	T0084	616.9
25	P	TTS reticle illumination system	Reticle illumination must be adjusted for each sight	None	8/5	T0088	
26	A1	Wearplate	Number two left inner support roller wearplate fell off	Replaced wearplate	8/8	T0090	630.9
27	A1	Centerguide	Centerguide missing on left track	Replaced centerguide	8/8	T0091	630.9
28	A	Wearplate	One part of #6 right inner wearplate missing	Replaced wearplate and bolts	8/8	T0096	630.9
29	P	T142 track pad	Track pad has 75% of the rubber missing on the left track	Replaced track pad	8/8	T0097	630.6
30	A1	Transmitter, temperature electrical	Transmitter cracked	Replaced transmitter	8/10	T0104	643.8
31	A1	Hull ammo rack handle	One right hull ammo rack handle bent and another missing	Replaced damaged and missing handles	8/10	T0105	643.8
32	P	TTS periscope head	The 8X reticle bulb burned out and moisture in the system	Replaced burned out bulb and purged the system	8/11	T0106	643.8

Component Code

A1 Standard M60A1 Part
P Product Improvement Part
X Experimental Part

SUMMARY REPORT

INCIDENT OF MALFUNCTION

PQ-3 TANK, S/N 7415

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
33	A1	Plate, wear	1/2 of a wearplate on #3 and #5 roadwheels	Replaced missing wearplates	8/13	T0110	643.8
34	A1	Centerguide	Centerguide missing on the right track	Replaced missing centerguide	8/13	T0111	643.8
35	P	TTS periscope head	1X and 8X bulb failures	Reticle bulb voltage lowered from 18 VDC to 14 VDC	8/13	T0126	643.8
36	A1	Centerguide	Centerguide missing on left track	Installed missing centerguide	8/15	T0127	808.0
37	P	TTS commander's display	Moisture in commander's display	Maintenance action deferred	8/16	T0128	735.7
38	P	TTS commander's display	See above	Commander's display was removed, cleaned, re-installed and purged	8/18	T0128 -S1	735.7
39	A1	M105D telescope	Reticle did not come back to boresight after switching ammo reticles	Maintenance action deferred	8/16	T0133	692.7
40	A1	Centerguide	Two centerguides missing and one failed on right track, and one centerguide missing and one failed on the left track	Replaced failed and missing components	8/19	T0143	833.0
41	A1	Roadwheel wearplate	#3 right inboard wearplate missing one bolt	Bolt threads stripped, had to replace wearplate	8/19	T0144	833
42	P	TTS commander's display	Moisture present in unit	NVL removed unit, dried internal portions, replaced seals and re-installed unit	8/19	T0145	833
43	P	TTS periscope head	Turning focus knob on the night sight caused the field of view to shift	Readjusted	8/19	T0146	846.8

Component Code

A1 Standard M60A1 Part
P Product Improvement Part
X Experimental Part

SUMMARY REPORT

INCIDENT OF MALFUNCTION

PQ-3 TANK, S/N 7415

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
44	A1	Battery ground	No apparent battery power	Fasteners on battery ground cables were tightened	8/19	T0147	833
45	A1	External handset (telephone)	Lost external telephone when cover opened	Maintenance action deferred for lack of parts.	8/18	T0148	822.1
46	A1	Air cleaner bolts	Five right air cleaner bolts were loose	Bolts were torqued	8/18	T0149	822.1
47	P	T142 track pad	Three track pads on the right track were missing rubber	Replaced track pads	8/19	T0150	833
48	A1	Traverse gearbox	Unable to traverse in power mode	Maintenance action deferred	8/22	T0163	860.8
49	A1	Main gun firing pin	Unable to fire main gun	Removed firing pin and cleaned pin and breech	8/22	T0164	860.8
50	P	TTS ballistic shield spring	Spring deformed taking a permanent set	TI and NVL replaced the spring	8/20	T0167	846.8
51	P	TTS ballistic shield assembly	Incomplete assembly installed at beginning of test	Complete assembly installed	8/20	T0168	846.8
52	P	TTS ballistic shield assembly	shoulder bolt fastening ballistic door failed	Replaced bolt	8/20	T0169	846.8
53	P	T142 track	Right track jumped the sprocket	By slowly moving the tank the track jumped into place on the sprocket	8/23	T0176	978.5
54	P	TTS commander's display	Something showing at 10:30 position in the display	Notified NVL	8/23	T0177	978.5
55	A1	Centerguide	Centerguide missing on right track	Replaced centerguide	8/23	T0178	978.5

Component Code

A1 Standard M60A1 Part
P Product Improvement Part
X Experimental Part

SUMMARY REPORT

INCIDENT OF MALFUNCTION

PQ-3 TANK, S/N 7415

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
56	A1	Support roller wearplate	Number 2 right inboard roadwheel has failed (sheared) bolts	Installed new wearplate	8/24	T0184	1046.3
57	A1	Centerguide	Centerguide missing on left track	Replaced missing centerguide	8/25	T0198	1080.1
58	P	Track pad	One outboard track pad missing on both tracks	Installed missing track pads	8/25	T0199	1080.1
59	A1	Centerguide	One centerguide missing on left track	Replaced missing centerguide	8/25	T0200	1117.1
60	A1	Centerguides	44 Loose centerguides on right track and 22 loose on left track	Loose centerguides were tightened	8/26	T0202	1117.1
61	P	Track pad	Track pads worn	Replaced all track pads	8/26	T0203	1117.1
62	A1	Centerguide	One centerguide bent on right track	Replaced bent centerguide	8/26	T0204	1117.1
63	A1	Traverse gearbox assembly	Unable to traverse in power mode	Replaced traverse gearbox	8/23	T0205	1117.1
64	A1	Control selector	Able to traverse turret without depressing palm switches	Replaced control selector	8/27	T0206	1117.1
65	P	T142 track link assy	Broken binocular pin	Replaced track link assy	8/26	T0207	1117.1
66	P	TTS components	Moisture in TTS components	Purged TTS components	8/26	T0208	1117.1
67	A1	105mm cannon firing pin	Firing pin dirty	Cleaned firing pin	8/27	T0214	1117.1
68	A1	Wedge-bolts	Loose wedge-bolts: 5 right track and 2 left track	Retightened wedge-bolts	8/29	T0215	1166.1

Component Code

A1 Standard M60A1 Part
P Product Improvement Part
X Experimental Part

SUMMARY REPORT

INCIDENT OF MALFUNCTION

PQ-3 TANK, S/N 7415

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
69	A1	Centerguide	Centerguide missing from left track	Replaced missing centerguide	8/30	T0219	1189.1
70	A1	Roadwheel	Number 3 right inner roadwheel has lost 40% of its rubber	Replaced roadwheel	8/30	T0220	1185.6
71	A1	Roadwheel wearplate	Number 3 right inner roadwheel wearplate missing	Replaced missing wearplate	8/31	T0224	1236.4
72	A1	Centerguide	Broken centerguide on the right track	Replaced centerguide	8/31	T0225	1314.2
73	A1	Ammo handle	Right ammo handle bent	Removed ammo handle and will install at appropriate time	8/31	T0226	1314.2
74	A1	Roadwheel	Right #4 roadwheel missing 45% of its rubber	Replaced roadwheel	9/11	T0227	1342.9
75	A1	Retainer assy	Plunger retaining pin sheared off	Replaced retainer assembly	8/30	T0228	1185.6
76	A1	Shock absorber cotter pin	Shock absorber retaining pin missing	Utilized a mil for a field fix and ordered the part	8/31	T0229	1314.2
77	P	Wind sensor most protection cover	Wind sensor protective cover missing	No replacement parts available	9/1	T0230	
78	A1	Nipple, drain tee	Hydraulic fitting leaking due to being hit by ammo handle	Maintenance action deferred	9/1	T0234	1342.9
79	A1	Nipple, drain tee	See above	Replaced drain tee nipple	9/15	T0234 -S1	1529.9
80	P	T142 track	Broken track pin	Replaced track shoe assembly	9/2	T0242	1440.2

Component Code

A1 Standard M60A1 Part
P Product Improvement Part
X Experimental Part

SUMMARY REPORT

INCIDENT OF MALFUNCTION

PQ-3 TANK, S/N 7415

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
81	A1	Centerguide	Centerguide bent on the left track in conjunction with above broken track pin	An additional track shoe assembly was replaced since the centerguide could not be removed	9/2	T0243	1440.2
82	A1	Centerguide	Lost two centerguides from right track	Replaced centerguides	9/6	T0246	1499.4
83	A1	Roadwheel wearplate	Portion of the #6 left roadwheel wearplate broken off	Replaced failed wearplate	9/7	T0254	1499.6
84	A1	Grooved pin and cotter pin - shock absorber to arm assembly	Shock absorber disconnected at roadwheel #2 right	Missing grooved pin and cotter pin replaced	9/7	T0255	1499.6
85	X	Air cleaner filter element	Air restriction indicators in red	Cleaned filters and reset indicators	9/7	T0258	1499.6
86	A1	Cotter pin - shock absorber to hull	Cotter pin missing utilized nail for field fix	Installed cotter pin	9/7	T0259	1499.6
87	P	Control selector assembly stab gunner's control	Stab system inoperative	Replaced control selector assembly	9/7	T0261	1499.6
88	P	T142 track	Loose track tension	Tightened both track assemblies to 12000 lbs.	9/7	T0262	1499.6
89	P	TTS power converter	The sight is noisy - shows vertical bars	Replaced A10 and A11 assemblies	9/12	T0295	1506.7
90	A1	Positive battery terminal adapter	Vehicle will not start	Broken adapter was replaced	9/13	T0296	1513.7

Component Code

A1 Standard M60A1 Part
P Product Improvement Part
X Experimental Part

SUMMARY REPORT

INCIDENT OF MALFUNCTION

PQ-3 TANK, S/N 7415

Item No.	Component		Incident	Action Taken	ITR		Test Miles
	Code	Nomenclature			Date	No.	
91	A1	Roadwheel seal assy	Number four left roadwheel seal leaking	Replaced seal assembly	9/13	T0297	1513.7
92	A1	Screw	Personnel heater exhaust pipe mounting clamp screw missing	Replaced screw	9/13	T0298	1513.7
93	A1	Left rear fender	Left rear fender is bent	Replaced left rear fender, dust shield and antisqueak pad	9/13	T0299	1513.7
94	A1	External handset assembly	External telephone missing	Replaced external telephone	9/13	T0300	1513.7
95	A	Manual firing mechanism	Manual firing circuit inoperative	Removed handle and feed - oiled mechanism	9/14	T0302	1529.7
96	P	TTS periscope head	No reticle	During maintenance validation J1 connector pins bent - straightened	9/14	T0303	1529.7

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TABLE 5-10

TTS DURABILTIY TEST LOG - PERISCOPE TIME

DATE	PQ-1 S/N7403 DAILY	TOTAL	SCOPE READING	PQ-2 S/N7406 DAILY	TOTAL	SCOPE READING	PQ-3 S/N7415 DAILY	TOTAL	SCOPE READING
7-19	4.0	4.0	118/112	3.0	3.0	99/102	0	0	126/130
7-20	11.0	15.0	133	12.0	15.0	114	4.0	4.0	126/130
7-21	15.0	30.0	148	14.0	29.0	128	9.0	13.0	139
7-22	4.0	34.0	152	13.0	42.0	141	1.0	14.0	140
7-23	5.0	39.0	157	1.0	43.0	142	4.0	18.0	144
7-25	8.0	47.0	165	8.0	51.0	150	9.0	27.0	153
7-26	18.0	65.0	183	20.0	71.0	170	16.0	43.0	169
7-27	14.0	79.0	197	10.0	81.0	180	15.0	58.0	184
7-28	6.0	85.0	203	0	81.0	180	10.0	68.0	194
7-29	6.0	91.0	209	0	81.0	180	6.0	74.0	200
7-30	10.0	101.0	219	5.0	86.0	185	16.0	90.0	216
8-1	8.0	109.0	227	0	86.0	185	4.0	94.0	220
8-2	18.0	127.0	245	13.0	99.0	198	14.0	108.0	234
8-3	15.0	142.0	260	13.0	112.0	211	11.0	119.0	245
8-4	17.0	159.0	277	9.0	121.0	220	15.0	134.0	260
8-5	17.0	176.0	294	15.0	136.0	235	16.0	150.0	276
8-6	0	176.0	294	19.0	155.0	254	0	150.0	276
8-8	11.0	187.0	305	9.0	164.0	263	14.0	164.0	290
8-9	20.0	207.0	325	21.0	185.0	284	21.0	185.0	311
8-15	18.0	225.0	343	3.0	188.0	287	14.0	199.0	325
8-16	14.0	239.0	357	12.0	200.0	299	9.0	208.0	334
8-17	13.0	252.0	370	9.0	209.0	308	12.0	220.0	346
8-18	18.0	270.0	388	10.0	219.0	318	15.0	235.0	361
8-19	12.0	282.0	400	7.0	226.0	325	15.0	250.0	376
8-22	16.0	298.0	416	7.0	233.0	332	16.0	266.0	392
8-23	0	298.0	416	14.0	247.0	346	16.0	282.0	408

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TABLE 5-10 (CONTINUED)

TTS DURABILITY TEST LOG - PERISCOPE TIME

DATE	PQ-1 S/N7403 DAILY	PQ-1 S/N7403 TOTAL	SCOPE READING	PQ-2 S/N7406 DAILY	PQ-2 S/N7406 TOTAL	SCOPE READING	PQ-3 S/N 7415 DAILY	PQ-3 S/N 7415 TOTAL	SCOPE READING
8-24	0	298.0	416	10.0	257.0	356	12.0	294.0	420
8-25	18.0	316.0	434	13.0	270.0	369	15.0	309.0	435
8-26	9.0	325.0	443	5.0	275.0	374	0	309.0	435
8-29	15.0	340.0	458	0	275.0	374	19.0	328.0	454
8-30	11.0	351.0	469	1.0	276.0	375	10.0	338.0	464
8-31	0	351.0	469	13.0	289.0	388	13.0	351.0	477
9-1	5.0	356.0	474	11.0	300.0	399	11.0	362.0	488
9-2	15.0	371.0	489	15.0	315.0	414	15.0	377.0	503
9-6	7.0	378.0	496	12.0	327.0	426	10.0	387.0	513
9-7	10.0	388.0	506	15.0	342.0	441	7.0	394.0	520
9-8	12.0	400.0	518	13.0	355.0	454	8.0	402.0	528
9-9	7.0	407.0	525	18.0	373.0	472	3.0	405.0	531
9-10	0	407.0	525	4.0	377.0	476	0	405.0	531
9-11	- -	- -	- -	- -	- -	- -	- -	- -	- -
9-12	8.0	415.0	533	13.0	390.0	489	8.0	413.0	539
9-13	2.0	417.0	535	7.0	397.0	496	0	413.0	539
9-14	0	417.0	535	7.0	404.0	503	7.0	420.0	546
9-15	0	417.0	535	3.0	407.0	506	0	420.0	546
9-16	3.0	420.0	538	5.0	412.0	511	0	420.0	546
9-19	11.0	431.0	549	0	412.0	511	5.0	425.0	551
FINAL READINGS	2.0	433.0	P 551	0	412.0	P 511	0	425.0	P 551
			C 521			C 469			C 472

TTS UNIT REMOVED FROM PQ-2 FRIDAY 16 SEPTEMBER AND RETURNED TO CWDD

TTS UNIT REMOVED FROM PQ-3 TUESDAY 20 SEPTEMBER AND SHIPPED TO NVL

TTS UNIT REMOVED FROM PQ-1 WEDNESDAY 21 SEPTEMBER AND SHIPPED TO NVL

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TABLE 6-11

DRIVER'S NIGHT VIEWER OPERATIONS LOG

DATE	AREA WHERE OPERATED	PQ-1 DAILY	TOTAL	PQ-2 DAILY	TOTAL	PQ-3 DAILY	TOTAL
8-5	MFO RANGE	2.0	2.0	2.0	2.0	2.0	2.0
8-8	MFO RANGE	2.0	4.0	2.5	4.5	2.0	4.0
8-16	MFO RANGE	2.0	6.0	2.0	6.5	2.5	6.5
8-19	MFO RANGE	0	6.0	0	6.5	0.5	7.0
8-23	CTA BOTTOMS	0	6.0	2.0	8.5	2.0	9.0
8-25	AREA SIX	4.0	10.0	2.0	10.5	2.0	11.0
9-2	CTA BOTTOMS	0	10.0	1.5	12.0	1.5	12.5
9-6	CTA BOTTOMS	2.5	12.5	0	12.0	0	12.5

TABLE 5-12

TEST VEHICLE PQ-1 FUEL CONSUMPTION

DATE 1977	TEST COURSE CONDITION	COURSE	ODOM AT REFILL	MILES BETWEEN REFILL	ACCUM TEST MILES	FUEL ADDED GALS	ACCUM FUEL ADDED	REFILL GPM	ACCUM TOTAL GPM		
7-11	INITIAL		2369.2	—		265	—				
7-23			2440.9	71.7	71.7	119.4	119.4	1.665	1.665		
7-26	DRY - DUSTY	MFO	2550.7	108.8	181.5	127.5	246.9	1.161	1.360		
7-27	DRY - DUSTY	MFO	2602.7	52	233.5	78	324.9	1.5	1.391		
7-28	DRY - DUSTY	MFO	2687.7	85	318.5	143	467.9	1.682	1.469		
7-30	WET - MUDDY	BOTTOMS	2760.2	72.5	391	167	634.9	2.303	1.623		
8-4	DRY - DUSTY	MFO	2999.3	239.1	630.1	242.9	877.8	1.015	1.393		
8-8	DRY - DUSTY	MFO	3100.5	101.2	731.3	130	1007.8	1.284	1.378		
8-15	WET - MUDDY	MFO	3146.0	45.5	776.8	111	1118.8	2.430	1.440		
8-16	WET - MUDDY	MFO	3229.2	83.2	860	205.6	1324.4	2.471	1.540		
8-22	WET - MUDDY	MFO	3352.8	123.6	983.6	119.6	1444.0	.967	1.468		
8-26	WET - MUDDY	BOTTOMS	3474.3	121.5	1105.1	119	1563	.979	1.414		
8-29	DRY - DUSTY	MFO	3605.0	130.7	1235.8	249	1812	1.905	1.466		
8-30	DAMP	MFO	3692.9	87.9	1323.7	184	1996	2.09	1.507		
9-2	DRY - DUSTY	MFO	3760.6	67.7	1391.4	163	2159	2.40	1.551		

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TABLE 5-13

TEST VEHICLE PQ-2 FUEL CONSUMPTION

DATE 1977	TEST COURSE CONDITION	COURSE	ODOM AT REFILL	MILES BETWEEN REFILL	ACCUM TEST MILES	FUEL ADDED GALS.	ACCUM FUEL ADDED	REFILL GPM	ACCUM TOTAL GPM		
7-6	INITIAL		2324.0	—	—	239.2	—	—	—		
7-23			2445.1	121	121	233.1	233.1	1.926	1.926		
7-26	DRY - DUSTY	MFO	2531.5	86.4	207.4	83.0	316.1	.960	1.524		
7-27	DRY - DUSTY	MFO	2586.3	54.8	262.2	80	396.1	1.459	1.510		
8-2	DRY - DUSTY	MFO	2650.9	64.6	326.8	88	484.1	1.362	1.461		
8-2	DRY - DUSTY	MFO	2672.8	21.9	348.7	54.7	538.8	2.497	1.545		
8-3	DRY - DUSTY	MFO	2686.9	14.1	362.8	20	558.8	1.418	1.540		
8-4	DRY - DUSTY	MFO	2715	28.1	390.9	62	620.8	2.206	1.584		
8-5	DRY - DUSTY	MFO	2748.2	27.2	418.1	52	672.8	1.911	1.609		
8-6	DRY - DUSTY		2780.7	38.5	456.6	106	778.8	2.753	1.705		
8-8	DRY - DUSTY	MFO	2872.1	91.4	548	206.9	985.2	2.258	1.797		
8-16	WET - MUDDY	MFO	2941.2	69.1	617.1	66.7	1051.9	.965	1.704		
8-17	DRY - DUSTY	MFO	3037.9	96.7	713.2	185	1239.9	1.913	1.738		
8-24	WET - MUDDY	MFO	3190	152.1	865.3	120	1356.9	.788	1.568		
9-1	DRY - DUSTY	MFO	3426	236	1101.3	164	1520.9	.694	1.381		
9-8	DRY - DUSTY	MFO	3593.5	167.5	1269.5	350	1870.9	2.089	1.473		

TABLE 5-14

TEST VEHICLE PQ-3 FUEL CONSUMPTION

DATE 1977	TEST COURSE CONDITION	COURSE	ODOM AT REFILL	MILES BETWEEN REFILL	ACCUM TEST MILES	FUEL ADDED GALS.	ACCUM FUEL ADDED	REFILL GPM	ACCUM TOTAL GPM		
7-23	INITIAL		2328.3	—	—	53	—	—	—		
7-26	DRY - DUSTY	MFO	2435.8	107.5	107.5	94	94	.874	.874		
7-27	DRY - DUSTY	MFO	2485.4	49.6	157.1	105	199	2.116	1.266		
7-28	DRY - DUSTY	MFO	2575.5	90.1	247.2	112	311	1.243	1.258		
7-30	WET MUDDY	BOTTOMS	2690.7	115.2	362.4	230	541	1.996	1.492		
8-2	DRY - DUSTY	MFO	2776.0	85.3	447.7	179.2	720.2	2.100	1.608		
8-3	DRY - DUSTY	MFO	2844.7	68.7	516.4	112	832.2	1.630	1.611		
8-4	DRY - DUSTY	MFO	2858.5	13.8	530.2	22	854.2	1.594	1.611		
8-5	DRY - DUSTY	MFO	2881.8	23.3	553.5	20	874.2	0.858	1.573		
8-8	DRY - DUSTY	MFO	2922.2	40.4	593.9	110	984.2	2.722	1.657		
8-15	WET - MUDDY	MFO	2949.1	26.9	620.8	56	1040.2	2.081	1.675		
8-16	WET - MUDDY	MFO	2990.9	41.8	662.6	86	1126.2	2.057	1.699		
8-17	DRY - DUSTY	MFO	3075.2	84.3	746.9	166	1292.2	1.969	1.730		
8-19	WET - MUDDY	BOTTOMS	3117.4	42.2	789.1	100	1392.2	2.369	1.764		
8-24	WET - MUDDY	MFO	3311	193.6	982.7	193	1585.2	.996	1.613		
8-29	DRY - DUSTY	MFO	3422	111	1093.7	108	1693.2	.972	1.548		
8-30	DAMP	MFO	3484.1	62.1	1155.8	73	1766.2	1.175	1.528		
8-31	DRY - DUSTY	MFO	3534.9	50.8	1206.6	110	1876.2	2.165	1.554		
9-1	DRY - DUSTY	MFO	3641.4	106.5	1313.1	162	2038.2	1.521	1.552		

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TABLE 5-15
TRACK TENSION DATA T-142

TANK NO.	REMARKS	DATE	TRACK TENSION ADJUSTMENT		DATE	TRACK TENSION AFTER OPER.		MILEAGE BTWN. CHECKS	
PQ-1		8/5	12000	12000	8/10	9000	8500	50	At "Q"
		8/10	12000	11500	8/16	7000	9000	150	
	Threw Track	8/16	12000	12000	8/22	10500	*	120	
	Track Failed	8/23	12000	12000	8/29	8000	*	255	
		8/29	12000	12000	9/9	8000	10000	160	
PQ-2		8/4	18000	18000	8/10	12000	9000	158	At "Q"
	Track Failed	8/10	17000	18000	8/17	13000	*	144	
	Track Failed	8/18	18000	17000	8/23	12500	*	134	
	Track Failed	8/23	18000	18000	8/25	*	13500	120	
		8/25	18000	18000	8/30	16500	18000	36	
		8/30	18000	18000	9/6	16500	18000	219	
		9/6	16500	17000	9/10	8000	13000	285	
PQ-3		8/6	12000	12000	8/11	11000	9000	27	At "Q"
		8/11	12000	12000	8/18	8000	8000	189	
	Threw Track	8/18	12000	12000	8/23	9000	*	145	
		8/23	12000	12000	8/26	7000	8500	133	
		8/26	11500	12000	8/31	8000	8000	204	
		8/31	12000	12000	9/7	9000	8500	186	

* See Remarks

NOTE: TRACK WAS ADJUSTED PER T-142 TRACK TENSIONING PROCEDURE FOR NEW TRACK TENSION GAGE. NEW GAGE USED.

6.0 SYSTEM VERIFICATION TEST REPORT

6.1 TEST OBJECTIVES

All three M60A3 tanks equipped with TTS systems were subjected to specification and daily checks. One PQT tank was used to perform system EMC and voltage level tests.

The objectives of the systems verification testing are:

a. Verification of total vehicle performance pre- and post-test.

b. Verification system performance during durability performance.

c. Evaluation of electrical transients and electromagnetic compatability between TTS and other tank systems.

d. Evaluation of effects of input voltage level or TTS system.

e. Measurement of firing shock and road vibration levels on TTS components.

6.2 CONCLUSIONS

Test data, specification tests, and boresight retention tests are presented in the following paragraphs. The results of the firing shock and road vibration, and the electrical transient/EMC tests are presented in Sections 9.0 and 10.0 of this report.

6.3 SPECIFICATION TESTS

Specification tests were performed before the tank was released for test and at the conclusion of the test program. This testing consisted of tests shown in Table 6-1.

TABLE 6-1

SPECIFICATION TEST REQUIREMENTS

SPEC PARAGRAPH NO.	TEST
3.5.2.2.1.1	Main Gun Synchronization Test
3.5.2.2.1.2	Main Gun Sighting System Elevation Backlash
3.5.2.2.1.3	Main Gun Sighting System B/S Knob Travel
3.5.2.2.1.5	Gunner's Thermal Night Vision
3.5.2.3.1	Computer Self Test
3.5.2.2.3.2	Jump and Zero Adjustment Accuracy
3.5.2.2.3	Ballistic Computer Solutions
3.5.2.2.1.6	Main Gun Sighting System Boresight Retention

The TTS scopes were removed from the tanks at completion of specification check and returned to NVL for checkout. The specification checks will be repeated upon installation of the new TTS equipment.

6.3.1 Test Results

6.3.1.1 Main Gun Synchronization Test

Table 6-2 provides the specification values recorded for Synchronization Tests. No out of tolerance values were experienced. Vehicle PQ-2 did not have a laser rangefinder.

TABLE 6-2

MAIN GUN SYNCHRONIZATION TESTS

	MAIN GUN	SPEC	PERISCOPE (MILS) DAY		PERISCOPE (MILS) THERMAL		TELESCOPE (MILS)		R.FINDER (MILS)	
TANK	POS	MILS	EL	DEP	EL	DEP	EL	DEP	EL	DEP
PQ-1	5°	±0.3	0	0	0	0	NO	NO	0	0
	10°	±0.3	0	0	0	0	NO	NO	0	0
	15°	±0.3	0.05	0	0	0	0	0	0	0.1
PQ-2	5°	±0.3	0.10	0.10	0.20	0.20	NO	NO	--	--
	10°	±0.3	0.10	0.10	0.20	0.20	NO	NO	--	--
	15°	±0.3	0.10	0.10	0.30	0.20	0	0	--	--
PQ-3	5°	±0.3	0.10	0.10	0	0	NO	NO	0	0
	10°	±0.3	0.10	0.10	0	0	NO	NO	0.20	0
	15°	±0.3	0.10	0.10	0	0	0	0	0.20	0

6.3.1.2 Main Gun Sighting System Elevation Backlash

Table 6-3 provides the specification values recorded for Elevation Backlash. No out of tolerance values were experienced. PQ-2 does not have a laser rangefinder.

TABLE 6-3

MAIN GUN SIGHTING SYSTEM ELEVATION BACKLASH

TANK NO.	GUN POS.	SPEC (MILS)	PERISCOPE (MILS) DAY	PERISCOPE (MILS) THERMAL	RANGEFINDER (MILS)
PQ-1	0^{o}	0.3	0	0	0
	5^{o}	0.3	0	0	0
	10^{o}	0.3	0	0.10	0.05
	15^{o}	0.3	0	0.10	0.10
PQ-2	0^{o}	0.3	0.10	0.10	-
	5^{o}	0.3	0.10	0.10	-
	10^{o}	0.3	0.10	0.10	-
	20^{o}	0.3	0.10	0.10	-
PQ-3	0^{o}	0.3	0	0	0
	5^{o}	0.3	0	0	0
	10^{o}	0.3	0	0	0
	25^{o}	0.3	0	0	0

6.3.1.3 Main Gun Sighting System B/S Knob Travel

Table 6-4 provides the specification values recorded for B/S knob travel. Before the test was conducted, TTS periscope head mirrors were adjusted by NVL personnel on PQ-1 and PQ-2. PQ-1 head mirror had less than 3.0 mils knob travel in depression in the thermal channel in boresight position. PQ-2 head mirror had less than 2.0 mils knob travel in elevation in the day channel in boresight position.

TABLE 6-4

MAIN GUN SIGHTING SYSTEM B/S KNOB TRAVEL

TANK NO.	SPEC (MILS)	CHANNEL (MILS) DAY	THERMAL	SPEC	RANGEFINDER
PQ-1	5 DN	6.6/13.1*	2.8/9.0*	3.5 DN	7.9
	2 UP	16.4/9.4*	19.5/12.5*	3.5 UP	11.8
	4 LEFT	15.5	6.0	3.5 LEFT	12.5
	4 RIGHT	6.8	16.5	3.5 RIGHT	11.9
PQ-2	5 DN	17.0/11.4*	15.0/7.9*		--
	2 UP	1.9/11.1*	4.5/11.2*		--
	4 LEFT	10.1	10.3		
	4 RIGHT	12.0	10.2		
	* Head mirror adjusted.				
PQ-3	5 DN	15.5	11.2	3.5 DN	13.5
	2 UP	6.4	9.3	3.5 UP	5.5
	4 LEFT	6.5	6.5	3.5 LEFT	11.2
	4 RIGHT	16.5	16.5	3.5 RIGHT	13.2

6.3.1.4 Gunner's Thermal Night Sight

Table 6-5 indicates operation of the thermal sight to be satisfactory on the three (3) contractor test vehicles.

TABLE 6-5

GUNNER'S THERMAL CHANNEL VISION

Actuate mode switch to "operate" provides thermal viewing at gunner and commander displays.

(.1) Switch at "Operate": Gunner View ok
Commander View ok

(.2) Maximum image brightness and Contrast, and Reticle Brightness by rotating switch to extreme clockwise position:

Image ok
Contrast ok
Reticle ok

(.3) Polarity switch reverses background ok

6.3.1.5 Computer Self Test

Table 6-6 indicates operation of the computer to be satisfactory in PQ-1 and PQ-3. On PQ-2, the computer shows a rangefinder malfunction. Rangefinder not in PQ-2.

TABLE 6-6

COMPUTER SELF TEST

(.1) Computer Control Unit Mode Selector Switch in "Lamp" position.

All malfunction lamps illuminate ok

(.2) Mode Switch in "Test" position

Green "go" lamp illuminates ok

6.3.1.6 Jump and Zero Adjustment Accuracy

Table 6-7 provides specification data for the jump and zero adjustment knobs. The computer jump knobs that did not meet specifications are indicated with an asterisk. Discrepancies in reading are attributed to backlash in knobs.

TABLE 6-7

JUMP AND ZERO ADJUSTMENT ACCURACY

(.1) 3.0 mil rotation of elevation jump knob in either direction shall cause a corresponding 3.0 ± 0.15 mil reading to appear on the output unit superelevation counter.

(.2) 3.0 mil rotation of elevation zeroing knob in either direction shall cause a corresponding 3.0 ± 0.15 mil reading to appear on the output unit superelevation counter.

		(.1) Jump				(.2) Zero
TANK NO.	ELEV KNOBS:	APDS	HEP/WP	Heat	BHIV	
PQ-1	(.1) + Rotation	3.1	3.0	3.1	3.1	3.0
	(.2) Return	3.05	2.95	3.0	3.0	2.9
	(.3) - Rotation	3.0	3.1	3.15	3.15	3.15
	(.4) Return	3.0	3.0	3.0	3.1	3.0
PQ-2	(.1) + Rotation	3.15	3.15	3.1	3.2 *	3.05
	(.2) Return	3.1	3.1	3.05	3.1	3.0
	(.3) - Rotation	3.15	3.1	3.15	3.2 *	3.05
	(.4) Return	3.1	3.1	3.05	3.2 *	3.05
PQ-3	(.1) + Rotation	3.1	3.2 *	3.2 *	3.1	3.0
	(.2) Return	3.1	3.1	3.1	3.0	3.0
	(.3) - Rotation	3.0	3.0	3.1	3.0	2.0
	(.4) Return	2.9	3.0	2.9	3.0	2.85

TABLE 6-7 - Continued

(.3) 3.0 mil rotation of the deflection jump (azimuth) knobs in either direction shall cause a corresponding 3.0 ± 0.15 mil movement of the gunner's periscope reticle in deflection.

(.4) 3.0 mil rotation of the deflection zeroing knob (azimuth) in either direction shall cause a corresponding 3.0 ± 0.15 mil movement of the gunner's periscope reticle in deflection.

		(.3) Jump				(.4) Zero
TANK NO.	AZIM KNOBS:	APDS	HEP/WP	Heat	BHIV	
PQ-1	(.1) + Rotation	3.1	3.1	3.1	3.0	3.15
	(.2) Return	3.1	3.1	3.1	2.95	3.10
	(.3) - Rotation	3.0	3.15	3.1	3.0	*3.25
	(.4) Return	3.05	3.15	3.1	3.0	*3.25
PQ-2	(.1) + Rotation	3.15	3.15	3.2	3.25*	3.15
	(.2) Return	3.0	2.95	2.9	3.05	3.05
	(.3) - Rotation	3.1	3.0	3.2	2.9	*2.7
	(.4) Return	2.9	2.85	2.9	2.8	*2.8
PQ-3	(.1) + Rotation	3.1	3.2 *	3.1	3.0	3.0
	(.2) Return	3.1	3.0	2.85	2.9	3.0
	(.3) - Rotation	3.0	3.2 *	3.0	3.0	3.1
	(.4) Return	2.9	3.0	2.9	2.9	3.0

6.2.1.7 Ballistic Computer Solutions

Tables 6-8 through 6-10 provide specification data for computer solutions.

All solutions for PQ-1 were satisfactory.

Target lead solutions on PQ-2 in stab and non-stab modes were out of spec as much as 18 mils. Boresight was checked and found to be satisfactory. Ran more tests but could get no closer than 7 mils. Target lead solutions were not recorded on PQ-2 because of the out of spec problems. NVL was requested to checkout the reticle projector in the post-test inspection of the PQ-2 periscope to resolve computer solution errors.

The laser rangefinder was not in PQ-2. Solutions from the commander's station could not be accomplished. In lieu of this, the gunner's thermal sight was used to record solutions.

Target lead solutions on PQ-3 were out of spec at the commander's station in moving mode-stab at 860 m 24 mils/sec cw, 1200 m 12 mils/sec cw, and 850 m 12 mils/sec ccw.

TABLE 6 - 8

BALLISTIC COMPUTER SOLUTIONS

PQ - 1

BASIC SOLUTIONS

Wind zero (manual mode), ALT zero, Ta +59°F (S) CANT zero (moving mode), range input from rangefinder, laser in test mode, ammo select by gunner as indicated, 1200 meters range inserted by laser battle range, remaining tube life 100%

Range		Elevation (Mils)					Deflection (Mils)				
		APDS-A1	APDS-A4	HEAT	HEP	B-HIV	APDS-A1	APDS-A4	HEAT	HEP	B-HIV
GUNNER'S STATION											
850	R	2.28 ± .50	2.33 ± .50	3.80 ± .50	9.88 ± .55	11.83 ± .55	.11 ± .4	.10 ± .40	.18 ± .40	-.18 ± 40	.02 ± .40
	A	2.40	2.30	3.80	10.05	11.80	.20	.25	.30	0	.05
1200	R	2.89 ± .50	3.07 ± .50	5.40 ± .55	14.82 ± .55	13.88 ± .55	-.10 ± .4	-.11 ± 40	0 ± .40	-.54 ± 60	-.23 ± .40
	A	3.05	3.10	5.50	14.80	14.00	.10	0	.20	-.45	0
1650	R	4.50 ± .50	4.80 ± .50	9.37 ± .55	26.58 ± .65	18.61 ± .55	-.31 ± .4	-.32 ± .40	-.15 ± .45	-1.13 ± .60	-.55 ± .45
	A	4.70	4.95	9.30	26.70	18.60	-.20	-.20	0	-.95	-.35
2850	R	7.58 ± .55	8.11 ± .55	18.61 ± .60	52.59 ± .90	28.18 ± .6	-.52 ± .40	-.53 ± .40	-.25 ± .55	-2.18 ± .90	-.97 ± .55
	A	7.70	8.20	18.50	52.70	28.35	-.35	-.30	0	-2.00	-.70
COMMANDER'S STATION											
850	R	2.20 ± .60	2.33 ± .60	3.80 - .60	9.88 ± .65	11.83 ± .60	.32 ± .45	.32 ± .45	.39 ± .45	.04 ± .50	.24 ± .50
	A	1.90	2.10	3.50	9.75	11.50	.10	.15	.35	-.20	.15
1200	R	2.89 ± .60	3.07 ± .60	5.40 ± .65	14.82 ± .65	13.88 ± .65	-.47 ± .45	-.47 ± .45	.37 ± .45	-.91 ± .55	-.60 ± .50
	A	2.75	3.00	5.10	14.50	13.65	-.25	-.35	-.10	-.75	-.40
1850	R	4.50 ± .60	4.80 ± .60	9.37 ± .65	26.58 ± .80	18.61 ± .65	-.49 ± .45	-.50 ± .45	-.33 ± .55	-1.31 ± .65	-.73 ± .55
	A	4.30	4.60	9.00	26.40	18.40	-.75	-.75	-.50	-1.50	-.85
2850	R	7.58 ± .65	8.11 ± .65	18.61 ± .70	52.59 ± .95	28.18 ± .70	-.82 ± .50	-.84 ± .50	-.55 ± .65	-2.48 ± .95	-1.28 ± .65
	A	7.40	7.90	18.10	52.35	27.80	-1.00	-1.00	-.70	-2.60	-1.30

TABLE 6 - 8A

CANT CORRECTION SOLUTIONS

STATIONARY MODE

Wind zero (manual mode), ALT zero, Ta +59°F (S) range input from rangefinder, laser in test mode, ammo select by gunner - HEP, remaining tube life 100%

Range		Elevation (Mils)		Deflection (Mils)	
		-15° Cant	+15° Cant	-15° Cant	+15° Cant
GUNNER'S STATION					
1850	R	25.42 ± .65	25.92 ± .65	-8.02 ± .60	5.83 ± .60
	A	25.00	25.40	-8.15	5.60
2850	R	50.28 ± .90	51.29 ± .90	-15.80 ± .90	11.57 ± .90
	A	50.00	50.85	-16.00	11.25
COMMANDER'S STATION					
1850	R	25.42 ± .80	25.92 ± .80	-8.20 ± .65	5.65 ± .65
	A	25.00	25.50	-8.50	5.40
2850	R	50.28 ± .90	51.29 ± .90	-16.10 ± .95	11.27 ± .95
	A	50.00	50.80	-16.25	10.95

MOVING MODE

Gunner's solutions, - Wind zero (manual mode), ALT zero, Ta +59°F (S), range input from rangefinder, laser in test mode, ammo select by gunner - HEP, remaining tube life 100% (new).

Range	Elevation	+15° Cant (Mils)	Deflection	+15° Cant (Mils)
GUNNER'S STATION				
2850		52.59 ± .90 52.00		-2.18 ± .90 -2.25

TABLE 6 - 8B

TARGET LEAD CORRECTION SOLUTIONS

(STATIONARY MODE, NON STABILIZED)

+59°F (S) ALT zero, Wind zero in manual mode, CANT zero, STATIONARY mode, STAB OFF; track at rates of 0, 04, 12, 24 mils/sec. Deflection solutions only, Ammo - HEAT,, remaining tube life 100% (new).

GUNNER'S STATION								
Range		Deflection at Tracking Rate (Mils)						
		24.0 CW*	12.0 CW*	4.0 CW*	0.0	4.0 CCW*	12.0 CCW*	24.0 CCW*
850	R	20.09 ± 1.00	-	3.50 ± .70	-	-	-9.78 ± .85	-
	A	20.85		3.70			-9.85	
1200	R	-	15.58 ± 1.00	-	-	-	-	-
	A		15.00					
1850	R	-	24.38 ± 1.35	-	-	-	-	-
	A	-	25.00					
2850	R	-	-	-	-.25 ± 1.35	-15.21 ± 1.68	-	-
	A				-.15	-15.00		
COMMANDER'S STATION								
Range		Deflection at Tracking Rate (Mils)						
		24.0 CW*	12.0 CW*	4.0 CW*	0.0	4.0 CCW*	12.0 CCW*	24.0 CCW*
850	R	-	-	-	-	-	-	-19.52 ± 1.10
	A							-20.50
1200	R	-	-	-	-	-5.23 ± .85	-	-
	A					-4.95		
1850	R	-	-	7.85 ± 1.00	-	-8.51 ± 1.05	-	-
	A			8.20		-8.60		
2950	R	-	-	14.41 ± 1.65	-	-	-	-
	A			15.15				

* CW - CLOCKWISE CCW - COUNTERCLOCKWISE

TABLE 6 - 8C

TARGET LEAD CORRECTION SOLUTIONS

(MOVING MODE, STABILIZED)

+ 59° F (S) ALT zero, Wind zero in manual mode, CANT zero, track at rates of 0, 4, 12, 24 mils/sec. Deflection solutions only, ammo HEAT. MOVING MODE STAB ON, remaining tube life 100% (new).

Range		Deflection at Tracking Rate (Mils)						
		24.0 CW	12.0 CW	4.0 CW	0.0	4.0 CCW	12.0 CCW	24.0 CCW
GUNNER'S STATION								
850	R	-	-	-	-	-	-	-19.74 ± 1.85
	A							-19.80
1200	R	-	-	-	-	-4.86 ± .90	-	-
	A					-5.20		
1850	R	-	-	8.03 ± 1.25	-	-8.33 ± 1.30	-	-
	A			8.00		-8.30		
2850	R	-	-	14.71 ± 2.20	-	-	-	-
	A			15.20				
COMMANDER'S STATION								
850	R	20.30 ± 1.95	-	3.71 ± .8	-	-	-9.57 ± 1.2	-
	A	21.30		3.80			-10.00	
1200	R	-	14.20 ± 1.6	-	-	-	-	-
	A		14.80					
1850	R	-	24.20 ± 2.45	-	-	-	-	-
	A		25.00					
2850	R	-	-	-	-.55 ± 1.15	-15.51 ± 2.25	-	-
					.15	-15.90		

TABLE 6 - 8D

REMAINING TUBE LIFE

Wind zero (manual mode), ALT zero, Ta+59° F (S) CANT zero (moving mode), range input from rangefinder, laser in test mode, ammo select by gunner, - HEP, 1200 meters range inserted by laser battle range, remaining tube life 0%

GUNNER'S STATION				
Range	Elevation (Mils)		Deflection (Mils)	
	Required	Actual	Required	Actual
1200	16.15 ± .55	15.90	-.59 ± .50	-.75

TABLE 6 - 8E

PQ - 1 MANUAL WIND/ALTITUDE/AIR TEMPERATURE CORRECTION SOLUTIONS

Wind 30 MPH from left (manual mode) ALT 2000, Ta -60°F, moving mode, ammo Select by commander - HEAT, range input from rangefinder, remaining tube life 100% (new).

GUNNER'S STATION				
Range	Elevation (Mils)		Deflection (Mils)	
	Required	Actual	Required	Actual
1850	9.20 ± .55	8.85	-3.62 ± .45	- 3.65
2850	18.01 ± .60	17.65	-6.52 ± .55	- 6.50

TABLE 6 - 9

BALLISTIC COMPUTER SOLUTIONS

PQ - 2

BASIC SOLUTIONS

Wind zero (manual mode), ALT zero, Ta +59°F (S) CANT zero (moving mode), range input from rangefinder, laser in test mode, ammo select by gunner as indicated, 1200 meters range inserted by laser battle range, remaining tube life 100%

Range *		Elevation (Mils)					Deflection (Mils)				
		APDS-A1	APDS-A4	HEAT	HEP	B-HIV	APDS-A1	APDS-A4	HEAT	HEP	B-HIV
~~800~~ 900	R	2.28 ± .50	2.33 ± .50	3.80 ± .50	9.88 ± .55	11.83 ± .55	.11 ± .4	.10 ± .40	.18 ± .40	-.18 ± 40	.02 ± .40
	A	2.15	2.25	3.75	9.75	11.65	0	.15	.20	-.10	-.10
~~1200~~ 1250	R	2.89 ± .50	3.07 ± .50	5.40 ± .55	14.82 ± .55	13.88 ± .55	-.10 ± .4	-.11 ± .40	0 ± .40	-.54 ± 60	-.23 ± .40
	A	2.90	3.10	5.30	15.00	13.80	0	-.15	0	-.45	-.35
~~1600~~ 1900	R	4.50 ± .50	4.80 ± .50	9.37 ± .55	26.58 ± .65	18.61 ± .55	-.31 ± .4	-.32 ± .40	-.15 ± .45	-1.13 ± .60	-.55 ± .45
	A	4.45	4.75	9.30	26.60	18.50	-.35	-.35	-.15	-1.00	-.60
~~2850~~ 2900	R	7.58 ± .55	8.11 ± .55	18.61 ± .60	52.59 ± .90	28.18 ± .6	-.52 ± .40	-.53 ± .40	-.25 ± .55	-2.18 ± .90	-.97 ± .55
	A	7.50	8.00	18.65	53.00	28.10	-.50	-.55	-.30	-2.10	-1.00
GUNNER'S STATION - TTS THERMAL SIGHT											
~~850~~ 900	R	2.20 ± .60	2.33 ± .60	3.80 - .60	9.88 ± .65	11.83 ± .60	.32 ± .45	.32 ± .45	.39 ± .45	.04 ± .50	.24 ± .50
	A	2.40	2.40	3.80	9.90	11.80	.20	0	.10	-.10	-.15
~~1200~~ 1250	R	2.89 ± .60	3.07 ± .60	5.40 ± .65	14.82 ± .65	13.88 ± .65	-.47 ± .45	-.47 ± .45	.37 ± .45	-.91 ± .55	-.60 ± .50
	A	3.00	3.00	5.30	14.90	13.80	-.20	0	0	-.50	-.35
~~1850~~ 1900	R	4.50 ± .60	4.80 ± .60	9.37 ± .65	26.58 ± .80	18.61 ± .65	-.49 ± .45	-.50 ± .45	-.33 ± .55	-1.31 ± .65	-.73 ± .55
	A	4.55	4.90	9.25	26.40	18.40	-.40	-.45	-.30	-1.00	-.70
~~2850~~ 2900	R	7.58 ± .65	8.11 ± .65	18.61 ± .70	52.59 ± .95	28.18 ± .70	-.82 ± .50	-.84 ± .50	-.55 ± .65	-2.48 ± .95	-1.28 ± .65
	A	7.60	8.00	18.70	53.00	28.15	-.55	-.80	-.40	-2.25	-1.10

* NO RANGEFINDER - MANUAL RANGE INPUT

TABLE 6 - 9A

CANT CORRECTION SOLUTIONS

STATIONARY MODE

Wind zero (manual mode), ALT zero, Ta +59°F (S) range input
from rangefinder, laser in test mode, ammo select by gunner - HEP, remaining tube life 100%

Range		Elevation (Mils)		Deflection (Mils)	
		-15° Cant	+15° Cant	-15° Cant	+15° Cant
~~1850~~ 1900	R	25.42 ± .65	25.92 ± .65	-8.02 ± .60	5.83 ± .60
	A	25.40	25.70	-8.00	6.00
~~2850~~ 2900	R	50.28 ± .90	51.29 ± .90	-15.80 ± .90	11.57 ± .90
	A	50.70	51.60	-15.50	11.55
COMMANDER'S STATION					
1850	R	25.42 ± .80	25.92 ± .80	-8.20 ± .65	5.65 ± .65
	A				
2850	R	50.28 ± 90	51.29 ± .90	-16.10 ± .95	11.27 ± .95
	A				

MOVING MODE

Gunner's solutions, - Wind zero (manual mode), ALT zero, Ta +59°F (S), range input from rangefinder, laser in test mode, ammo select by gunner - HEP, remaining tube life 100% (new).

GUNNER'S STATION				
Range	Elevation	+15° Cant (Mils)	Deflection	+15° Cant (Mils)
~~2850~~ 2900		52.59 ± .90		-2.18 ± .90
		53.00		-1.50

TABLE 6 - 9B

REMAINING TUBE LIFE

Wind zero (manual mode), ALT zero, Ta+59° F (S) CANT zero (moving mode), range input from rangefinder, laser in test mode, ammo select by gunner, - HEP, 1200 meters range inserted by laser battle range, remaining tube life 0%

GUNNER'S STATION				
	Elevation (Mils)		Deflection (Mils)	
Range	Required	Actual	Required	Actual
~~1200~~ 1250	16.15 ± .55	15.85	-.59 ± .50	-.45

TABLE 6 - 9C

MANUAL WIND/ALTITUDE/AIR

TEMPERATURE CORRECTION SOLUTIONS

Wind 30 MPH from left (manual mode) ALT 2000, Ta -60°F, moving mode, ammo select by commander - HEAT, range input from rangefinder, remaining tube life 100% (new).

GUNNER'S STATION				
	Elevation (Mils)		Deflection (Mils)	
Range	Required	Actual	Required	Actual
~~1850~~ 1900	9.20 ± .55	8.75	-3.62 ± .45	-3.45
~~2850~~ 2900	18.01 ± .60	17.60	-6.52 ± .55	-6.40

TABLE 6 - 10

BALLISTIC COMPUTER SOLUTIONS

PQ - 3

BASIC SOLUTIONS

Wind zero (manual mode), ALT zero, Ta +59°F (S) CANT zero (moving mode), range input from rangefinder, laser in test mode, ammo select by gunner as indicated, 1200 meters range inserted by laser battle range, remaining tube life 100%

Range		Elevation (Mils)					Deflection (Mils)				
		APDS-A1	APDS-A4	HEAT	HEP	B-HIV	APDS-A1	APDS-A4	HEAT	HEP	B-HIV
GUNNER'S STATION											
850	R	2.28 ± .50	2.33 ± .50	3.80 ± .50	9.88 ± .55	11.83 ± .55	.11 ± .4	.10 ± .40	.18 ± .40	-.18 ± 40	.02 ± .40
	A	1.90	1.90	3.35	9.50	11.40	-.10	-.20	-.05	-.35	-.10
1200	R	2.89 ± .50	3.07 ± .50	5.40 ± .55	14.82 ± .55	13.88 ± .55	-.10 ± .4	-.11 ± 40	0 ± .40	-.54 ± 60	-.23 ± .40
	A	2.45	2.60	5.00	14.45	13.50	-.40	-.35	-.25	-.70	-.40
1680	R	4.50 ± .50	4.80 ± .50	9.37 ± .55	26.58 ± .65	18.61 ± .55	-.31 ± .4	-.32 ± .40	-.15 ± .45	-1.13 ± .60	-.55 ± .45
	A	4.10	4.45	9.00	26.25	18.30	-.55	-.50	-.30	-1.40	-.75
2850	R	7.58 ± .55	8.11 ± .55	18.61 ± .60	52.59 ± .90	28.18 ± .6	-.52 ± .40	-.53 ± .40	-.25 ± .55	-2.18 ± .90	-.97 ± .55
	A	7.25	7.75	18.00	52.10	27.90	-.70	-.60	-.40	-2.50	-1.15
COMMANDER'S STATION											
850	R	2.20 ± .60	2.33 ± .60	3.80 - .60	9.88 ± .65	11.83 ± .60	.32 ± .45	.32 ± .45	.39 ± .45	.04 ± .50	.24 ± .50
	A	1.90	2.00	3.35	9.50	11.45	0	-.10	.20	-.25	0
1200	R	2.89 ± .60	3.07 ± .60	5.40 ± .65	14.82 ± .65	13.88 ± .65	-47 ± .45	-.47 ± .45	.37 ± .45	-.91 ± .55	-.60 ± .50
	A	2.50	2.60	5.00	14.45	13.55	-.35	-.40	.10	-.80	-.45
1850	R	4.50 ± .60	4.80 ± .60	9.37 ± .65	26.58 ± .80	18.61 ± .65	-.49 ± .45	-.50 ± .45	-.33 ± .55	-1.31 ± .65	-.73 ± .55
	A	4.20	4.50	9.00	26.25	18.25	-.75	-.70	-.50	-1.50	-.85
2850	R	7.58 ± .65	8.11 ± .65	18.61 ± .70	52.59 ± .95	28.18 ± .70	-.82 ± .50	-.84 ± .50	-.55 ± .65	-2.48 ± .95	-1.28 ± .65
	A	7.25	7.90	18.25	52.25	27.75	-1.00	-1.00	-.65	-2.70	-1.35

TABLE 6 - 10A

CANT CORRECTION SOLUTIONS

STATIONARY MODE

Wind zero (manual mode), ALT zero, Ta +59°F (S) range input from rangefinder, laser in test mode, ammo select by gunner - HEP, remaining tube life 100%

Range		Elevation (Mils)		Deflection (Mils)	
		-15° Cant	+15° Cant	-15° Cant	+15° Cant
GUNNER'S STATION					
1850	R	25.42 ± .65	25.92 ± .65	-8.02 ± .60	5.83 ± .60
	A	25.05	25.55	-8.30	5.50
2850	R	50.28 ± .90	51.29 ± .90	-15.80 ± .90	11.57 ± .90
	A	49.90	50.70	-16.05	11.30
COMMANDER'S STATION					
1850	R	25.42 ± .80	25.92 ± .80	-8.20 ± .65	5.65 ± .65
	A	25.00	25.65	-8.65	5.35
2850	R	50.28 ± .90	51.29 ± .90	-16.10 ± .95	11.27 ± .95
	A	50.00	51.00	-16.50	11.00

MOVING MODE

Gunner's solutions, - Wind zero (manual mode), ALT zero, Ta +59°F (S), range input from rangefinder, laser in test mode, ammo select by gunner - HEP, remaining tube life 100% (new).

Range	Elevation	+15° Cant (Mils)	Deflection	+15° Cant (Mils)
GUNNER'S STATION				
2850		52.59 ± .90		-2.18 ± .90
		52.40		-2.70

TABLE 6 - 10B

TARGET LEAD CORRECTION SOLUTIONS
(STATIONARY MODE, NON-STABILIZED)

$+59^{O}F$ (S) ^{O}F ALT zero, Wind zero in manual mode, CANT zero, STATIONARY mode, STAB OFF; track at rates of 0, 04, 12, 24 mils/sec. Deflection solutions only, Ammo - HEAT,, remaining tube life 100% (new).

GUNNER'S STATION								
Range		Deflection at Tracking Rate (Mils)						
		24.0 CW*	12.0 CW*	4.0 CW*	0.0	4.0 CCW*	12.0 CCW*	24.0 CCW*
850	R	20.09 ± 1.00	-	3.50 ± .70	-	-	-9.78 ± .85	-
	A	20.65/20.80		3.50/3.30			-10.40/-10.30	
1200	R	-	15.58 ± 1.00	-	-	-	-	-
	A		15.20/15.20					
1850	R	-	24.38 ± 1.35	-	-	-	-	-
	A	-	25.00/25.50					
2850	R	-	-	-	-.25 ± 1.35	-15.21 ± 1.68	-	-
	A				-.70/-.65	-16.15/-16.50		

COMMANDER'S STATION								
Range		Deflection at Tracking Rate (Mils)						
		24.0 CW*	12.0 CW*	4.0 CW*	0.0	4.0 CCW*	12.0 CCW*	24.0 CCW*
850	R	-	-	-	-	-	-	-19.52 ± 1.10
	A							-19.85
1200	R	-	-	-	-	-5.23 ± .85	-	-
	A					-5.15		
1850	R	-	-	7.85 ± 1.00	-	-8.51 ± 1.05	-	-
	A			8.10		-8.65		
2850	R	-	-	14.41 ± 1.65	-	-	-	-
	A			13.95				

* CW - CLOCKWISE CCW - COUNTERCLOCKWISE
DAYSIGHT/NIGHTSIGHT

TABLE 6 - 10C

TARGET LEAD CORRECTION SOLUTIONS
(MOVING MODE, STABILIZED)

+ 59° F (S) ALT zero, Wind zero in manual mode, CANT zero, track at rates of 0, 4, 12, 24 mils/sec. Deflection solutions only, ammo HEAT. MOVING MODE STAB ON, remaining tube life 100% (new).

Range		Deflection at Tracking Rate (Mils)						
		24.0 CW	12.0 CW	4.0 CW	0.0	4.0 CCW	12.0 CCW	24.0 CCW
GUNNER'S STATION								
850	R	-	-	-	-	-	-	-19.74 ± 1.85
	A							-20.60/-19.60
1200	R	-	-	-	-	-4.86 ± .90	-	-
	A					-5.00/-5.20		
1850	R	-	-	8.03 ± 1.25	-	-8.33 ± 1.30	-	-
	A			9.10/8.30		-8.50/-8.35		
2850	R	-	-	14.71 ± 2.20	-	-	-	-
	A			15.25/14.30				
COMMANDER'S STATION								
850	R	20.30 ± 1.95	-	3.71 ± .8	-	-	-9.57 ± 1.2	-
	A	22.30 *		3.80			-11.00 *	
1200	R	-	14.20 ± 1.6	-	-	-	-	-
	A		16.00 *					
1850	R	-	24.20 ± 2.45	-	-	-	-	-
	A		26.25					
2850	R	-	-	-	-.55 ± 1.15	-15.51 ± 2.25	-	-
					-.60	-17.00		

* NOT IN SPEC AFTER 4 TRIALS
DAYSIGHT/NIGHTSIGHT

TABLE 6 - 10D

REMAINING TUBE LIFE

Wind zero (manual mode), ALT zero, Ta+59° F (S) CANT zero (moving mode), range input from rangefinder, laser in test mode, ammo select by gunner, - HEP, 1200 meters range inserted by laser battle range, remaining tube life 0%

GUNNER'S STATION				
	Elevation (Mils)		Deflection (Mils)	
Range	Required	Actual	Required	Actual
1200	16.15 ± .55	15.95	-.59 ± .50	-.70

TABLE 6 - 10E

MANUAL WIND/ALTITUDE/AIR
TEMPERATURE CORRECTION SOLUTIONS

Wind 30 MPH from left (manual mode) ALT 2000, Ta -60°F, moving mode, ammo select by commander - HEAT, range input from rangefinder, remaining tube life 100% (new).

GUNNER'S STATION				
	Elevation (Mils)		Deflection (Mils)	
Range	Required	Actual	Required	Actual
1650	9.20 ± .55	8.80	-3.62 ± .45	-3.60
2850	18.01 ± .60	17.55	-6.52 ± .55	-6.45

6.3.1.8 Main Gun Sighting System Boresight Retention

Table 6-11 provides specification data for boresight retention.

TTS periscope and telescope did not pass boresight retention on first 8 mile run on PQ–1. The sights were boresighted and another run of 8 mils was conducted. The TTS sights in elevation was off 0.8 mils against a spec of 0.25 mils.

Sights on PQ-2 held boresight except for the thermal sight which was off .05 mils. The laser rangefinder is not in PQ-2. It was found when laying on target with the day sight elevation B/S knob, the B/S knob was slipping. The knob was rotated 0.6 mils with only a 0.2 mil reticle travel. The problem was not corrected. Boresight retention on PQ–3 was satisfactory.

TABLE 6-11

MAIN GUN SIGHTING SYSTEM BORESIGHT RETENTION

(.1) After 8 miles of vehicle operation, the daylight and thermal lines on sight of gunner's periscope shall maintain previously established boresight with the main gun within + .25 mil in elevation and deflection. The gunner's telescope shall maintain boresight within ± 0.15 mil.

NOTE

Use a thermal target for gunner's periscope thermal channel check.

TANK NO.			1st TRIAL/2nd TRIAL ELEVATION			DEFLECTION	
PQ-1	Gunner's Per.	(Daylight) (.1)	.10/.80	mil	(.2)	.20/.20	mil
		(Thermal) (.3)	.50/.80	mil	(.4)	.35/.20	mil
	Telescope	(.5)	.20/	mil	(.6)	.05/	mil
PQ-2	Gunner's Per.	(Daylight) (.1)	.20	mil	(.2)	0	mil
		(Thermal) (.3)	.30	mil	(.4)	.20	mil
	Telescope	(.5)	0	mil	(.6)	0	mil
PQ-3	Gunner's Per.	(Daylight) (.1)	.25	mil	(.2)	.20	mil
		(Thermal) (.3)	.20	mil	(.4)	.10	mil
	Telescope	(.5)	.10	mil	(.6)	0	mil

TABLE 6-11 - (Continued)

(.2) After 8 miles of vehicle operation, the optical LOS of the laser rangefinder shall maintain previously established boresight with the main gun within ± 0.50 mils in elevation and 0.40 mils in deflection.

PQ-1	(.1)	LRF - Elevation	.15	mils
	(.2)	LRF - Deflection	.05	mils
PQ-2	(.1)	LRF - Elevation	--	mils
	(.2)	LRF - Deflection	--	mils
PQ-3	(.1)	LRF - Elevation	.30	mils
	(.2)	LRF - Deflection	.10	mils

6.4 POST OPERATION CHECKS

At the end of each eight hour shift, post-operation evaluation tests were performed.

The computer, laser, and TTS built-in test equipment (BITE) checks were performed with the required crew "before operation" checks outlined in operator's manual. The BITE and functional checks were repeated periodically during the day's operation and at the conclusion of the shift operation. The BITE test did not indicate any failures other than power converter problems experienced during pretest activity.

Boresight retention readings were taken during all vehicle firing exercises. The retention readings will be taken utilizing a V block mounted reference scope. Table 6-12 provides boresight retention data taken before and after each firing mission. The data provided contains the boresight variances of the TTS sights, telescope, rangefinder, and muzzle scope with respect to the reference scope. These variances are attributed to the test procedure and do not provide conclusive evidence of the magnitude of any boresight shift. The hit probability resulting from the firing exercises does not support the boresight shifts indicated by the test data. Since boresight was accomplished daily with the gun muzzle as reference, the change of boresight knob settings from day-to-day cannot be used as an indication of boresight shifts within the optical instruments, as the muzzle is known to vary at other than predictable magnitudes.

TABLE 6-12

BORESIGHT RETENTION

BORESIGHT SHIFT USING REFERENCE TELESCOPE AS ZERO (MILS)

				105D		TTS DAY SIGHT		TTS THERMAL SIGHT		LRF		MUZZLE	
DATE	TANK NO.	RDS FIRED	TEMP	AZ	EL	AZ	EL	AZ	EL	AZ	EL	AZ	EL
7/27/77	PQ-1	38	67-82	.05	.05	1.65	2.30	-	-	.20	1.75	-.35	-.70
8/1/77	PQ-1	32	80-98	-.325	.475	.425	0	.425	-.25	.80	.55	-.20	-.75
8/4/77	PQ-1	41	98-102	-.30	0	.40	.05	0	.15	.35	.25	.10	-.70
8/5/77	PQ-1	25	99-102	-.20	-.35	.05	-.40	-.55	-.15	.15	-.05	-.20	-.90
8/18/77	PQ-1	23	87-80	0	-.20	-.05	-.25	.40	-.80	-.25	-.40	.50	-.50
8/19/77	PQ-1	26	82-80	-.10	-.05	-.60	-.20	.50	0	0	-.25	.15	-.55
8/22/77	PQ-1	8	72-78	0	.05	0	0	-	-	0	.15	0	-.60
8/30/77	PQ-1	36	95-103	-.05	0	.25	.25	.10	0	0	.50	0	-.75
8/31/77	PQ-1	25	84-108	-.05	0	.05	-.30	.15	-.35	.15	.65	-.05	-.75
9/2/77	PQ-1	15	80-90	.40	-.70	.25	0	.45	-.15	.15	.30	.30	-.55
7/27/77	PQ-2	21	67-82	-.25	0	-.25	.375	.25	.25	.10	.40	-.25	-.50
8/2/77	PQ-2	23	86-92	.35	-.95	.475	-.45	-.40	-.325	-.20	-.10	-.15	-.95
8/3/77	PQ-2	34	78-92	-.30	-.05	-.525	1.15	.075	-.05	-	-	-.30	-.85
8/5/77	PQ-2	19	78-96	.20	.05	.10	-.075	-.30	-.075	-.40	.30	-.40	-.20
8/15/77	PQ-2	18	93-94	.30	.45	.20	1.25	-2.40	.10	0	0	.25	-.50
8/18/77	PQ-2	50	87-78	.85	.15	-.15	-.10	-.20	-.05	-.05	-.45	0	-.35
8/23/77	PQ-2	9	78-80	-.05	-.10	.15	-.10	.10	-.25	.05	.30	.10	-.50
9/1/77	PQ-2	52	80-95	-1.40	.05	.55	-.55	-.15	0	-.25	.40	-.30	-.60
7/27/77	PQ-3	38	81-85	-.175	.65	.425	.30	.825	.15	.375	.60	.075	-1.35
8/2/77	PQ-3	24	-	-.05	.15	.65	.10	-.25	.40	.40	.75	-.25	-.60
8/4/77	PQ-3	60	84-95	-.025	0	.05	.25	-.25	.75	.15	.55	.35	-.10
8/15/77	PQ-3	12	81-92	-.05	.25	.20	-.35	-.10	-.40	.75	.35	-.10	-.20
8/16/77	PQ-3	25	80-84	-	-	.20	.50	.30	.50	.15	.40	-.15	-.45
8/19/77	PQ-3	47	82-75	.15	.20	-.30	-.10	0	0	-.10	-.55	.10	-.70

7.0 FIRING TEST SUMMARY

7.1 BACKGROUND

Contractor testing of the M60A3 tank was initiated on 19 July 1977.

A summary of the ammunition allocation and expenditures during testing is shown in Table 7-1. The objectives, conclusions, and results of the testings are provided in the following paragraphs. Detailed hit probability analysis of the contractor test firing program are presented in a separate classified report dated 15 November 1977.

7.2 OBJECTIVES

The objectives of the contractor test firing program were:

1. To determine if the Tank Thermal Sight (TTS) can be used effectively as a component of a day/night fire control system.

2. To subject the tank thermal sight to the shock environment created by firing of the 105mm main gun.

3. To determine the accuracy of fire of the M60A3 using the Tank Thermal Sight System (TTS).

4. To provide data for determining the hit probability of the M60A3 using the Tank Thermal Sight System (TTS).

7.3 TEST DISCUSSION

7.3.1 Schedule

The final firing schedule was established when the vehicles were on-site at Fort Knox. Firing was initiated on PQ-1 and PQ-2 on 19 July 1977 and on PQ-3 on 20 July 1977. Shock firing program was conducted on PQ-1 on 21 July and on PQ-2 on 25 July 1977. Firing on all three PQT-C tanks was completed on 2 September 1977.

7.3.2 Test Method

During the period of contractor testing at Fort Knox, Kentucky, the test operation combined military firing crews with Chrysler personnel in a two-shift operation. One shift was devoted to actual firing exercises conducted by military crews and monitored by Chrysler test engineers. The other shift was operated solely by Chrysler personnel and was devoted to durability testing and vehicle maintenance. All malfunctions and failures were reported in interim test reports which have been documented in the Reliability section of this test report. A summary of the firing is shown in the following paragraphs. Detailed test procedures are provided in Attachment No. 3, Armament Test Procedure of the Contractor Prototype Qualification Test (PQT-C) Plan M60A3 (PI) Tank Thermal Sight (TTS) AN/VSG-2 dated 1 June 1977.

7.3.3 Conclusions

The M60A3 PQT-C Contractor Engineering Firing Test Objectives were successfully accomplished. The Tank Thermal Sight (TTS) was subjected to main gun firing shock with no pattern failure attributed to the shock environment. More main gun ammunition was expended than that allocated for in the test plan, refer to Table 7-1. The ammunition expended over allocation was for new lot zeroing and dispersion firing, rerun of some tests due to environmental conditions (fog) and firing demonstrations. The firing log, figure 7-2, indicates the type of firing conducted and rounds expended. In the area of firing accuracy, the data from the three PQT-C test tanks is comparable to previous M60A1 (PI) firing tests.

Firing of the secondary weapon systems was accomplished satisfactorily according to the test plan except only 200 rounds of 7.62mm were fired instead of 800 rounds as allocated.

TABLE 7-1
AMMUNITION ALLOCATION
CONTRACTOR ENGINEERING TEST

TANK NO.	MAIN GUN ROUNDS HEAT-TP-T M490 PLAN	HEAT-TP-T M490 ACTUAL	TPDS-T M724 PLAN	TPDS-T M724 ACTUAL	SECONDARY WEAPON ROUNDS 7.62MM PLAN	7.62MM ACTUAL	50 CAL PLAN	50 CAL ACTUAL
PQ-1	166	266	130	143	800		170	
PQ-2	166	196	130	133		200		170
PQ-3	130	198	130	140				
TOTAL	462	660	390	416	800	200	170	170

FIGURE 7-2. FIRING LOG

DATE	PQ-1 7403 TYPE FIRING	HEAT	TPDS	PQ-2 7406 TYPE FIRING	HEAT	TPDS	PQ-3 7415 TYPE FIRING	HEAT	TPDS
7/19	PROOF	3		PROOF	3				
7/20	ZEROING	16	11	ZEROING	11	11	PROOF	3	
7/21	SHOCK	47					ZEROING	14	
7/25				SHOCK	36		ZEROING	7	11
7/26	DISPERSION	18	14	DISPERSION	14	13			
7/27	DISPERSION	17	10	DISPERSION	17	10	DISPERSION	24	23
8/1	HIT PROB STA-STA	27	6						
8/2	ZERO CONFIRM	12		HIT PROB STA-STA	23		HIT PROB STA-STA	24	
8/3				HIT PROB STA-STA		42			
8/4	HIT PROB STA-STA		41				HIT PROB STA-STA	17	40
8/5	HIT PROB STA-STA	26		HIT PROB STA-STA	19				
8/15				HIT PROB STA-STA	18		HIT PROB STA-STA	12	
8/16							DISPERSION (NEW LOT)	25	
8/17	ZERO CONFIRM	10		ZERO CONFIRM		8	ZERO CONFIRM	3	3
8/18	HIT PROB STA-STA NIGHT	23		HIT PROB STA-STA NIGHT	27	23			
8/19	HIT PROB STA-STA NIGHT		26				HIT PROB STA-STA NIGHT	26	22
8/22	REZERO (NEW LOT)	24							
8/29							HIT PROB STA-MOV TAR.		25
8/29							HIT PROB STA-STA NIGHT		14
8/30	HIT PROB STA-MOV TAR		20				HIT PROB STA-MOV TAR	24	
8/30	HIT PROB STA-STA NIGHT		15						
8/31	HIT PROB STA-MOV TAR	25							
9/1				HIT PROB STA-MOV TAR	28	26			
9/2	HIT PROB STA-MOV TAR	18							
9/9							FIRING DEMONSTRATION	1	
9/12							FIRING DEMONSTRATION	18	2
	TOTALS	266	143		196	133		198	140

8.0 HUMAN FACTORS

8.1 OBJECTIVES

The objectives of this portion of the test program were:

a. To identify any human factor problems associated with installation, operation and maintenance of the TTS.

b. To provide evaluation data to determine if the TTS system is ready for DT II/OT II testing.

8.2 DISCUSSION

8.2.1 HFE - Reliability Testing

The contractor test crews operating the test tanks during reliability mileage recorded human factor problems and suggestions via the Interim Test Report form (ITR). These ITR's are included in the ITR Summary Report, Tables 5-7, 5-8, and 5-9.

Chrysler Warren Defense Division (CWDD) Human Factors and Safety (HF&S) personnel assessed the AN/VSG-2 Tank Thermal Sight (TTS) installed in an M60A3 during actual vehicle operation and live firing exercises at Fort Knox on 15 through 18 August 1977. These day and night operational assessments of the TTS were primarily directed towards the identification of the required protection of operating personnel and equipment, TTS interfaces in the area of safety, and convenience of operation. The results of this assessment were published and distributed to the Government in a separate document, Human Factors and Safety Assessment, dated 30 September 1977.

8.2.2 Human Factor Questionnaires

The Human Factors Engineering Questionnaire was completed by the tank crewmen about half-way through the test and again after completion of the test. Two crewmen who completed the questionnaire during the test were not present at the end of the test and therefore did not complete the questionnaire at that time. One crewman who filled out the questionnaire at the end of the test did not fill out the questionnaire during the test. Eight crewmen filled out the questionnaire both times. As noted in the discussions of the individual questions, the answers given by the eight crewmen who completed the questionnaire twice were not always consistent. The answers to the questionnaires indicated the following:

1. All crewmen liked the TTS performance/capability.

2. The crewmen believed that the TTS was not difficult to operate.

3. While the wide field of view/narrow field of view control was one of the most liked features on the TTS, a majority of the crewmen thought that it should be relocated for better accessibility.

4. The noisiness of the cryogenic cooler was the most disliked TTS feature.

5. Several crewmen suffered scraped knuckles by hitting their hands on the reticle knob guard during manual traverse handle rotation (this problem has been corrected).

6. Many crewmen experienced eyestrain and fatigue from both day and night channel viewing. Operators with imperfect (faulty) vision should wear properly fitted eyeglasses when operating the TTS.

7. The item mentioned most frequently as an unsafe feature was inadequate head protection (browpads/eyeguards) for both the gunner and tank commander.

Favorable/Unfavorable Responses

The general satisfaction with the TTS performance/capability is evident from the responses to almost every question.

Nine questions were related to subjective evaluation of the TTS by each crewman. These questions were:

How do you feel about the TTS?

Would you recommend any changes to the TTS?

Do you feel there are any unsafe features about the TTS?

Do you feel the average operator will be able to operate with this system equally as efficient as with any other system?

Do you feel the average repairman will be able to troubleshoot and repair this system?

Do you feel that the average operator will be able to: Operate this equipment? Service this equipment? Remove and install this equipment?

Are gauges, dials, scales, and numbers adequate for clear vision during: Day operation? Night operation? Unusual weather conditions?

Do you feel that instructions, labels, decals, etc., are adequate?

Do you feel that warning instructions, labels, and decals are adequate?

Two questions also related to a subjective evaluation of the TTS were not included in this favorable/unfavorable reaction summary because they called for either a favorable or unfavorable answer but did not give a choice. The following question called for only favorable answers:

What features did you like best about the TTS?

On the other hand, the following question called for unfavorable answers:

What features did you dislike most about the TTS?

The following questions were included in the favorable/unfavorable reaction summary even though the former "begs" for a favorable answer, and the latter was almost sure to be answered with an unfavorable response by anyone who had listed a feature that he "disliked most about the TTS":

How do you feel about the TTS?

Would you recommend any changes to the TTS?

The nature of the question, of course, determined what would be considered a favorable or unfavorable response. For example, a YES answer to "Do you feel that the average repairman will be able to troubleshoot and repair this system?" is favorable, while a YES answer to "Do you feel there are any unsafe features about the TTS?" is unfavorable.

Table I is a summary of the favorable/unfavorable responses to the nine questions relating to the crewmen's subjective feelings about the TTS. As shown in the table, in the first and second questionnaires a majority of the crewmen responded favorably to seven out of nine of these questions. In the total responses to all nine questions, 79 out of 113, or 70%, of the responses were favorable on the first questionaire, and 97 out of 131, or 74%, of the responses were favorable on the second questionnaire. This indicates an overall favorable reaction to the TTS by the crewmen completing the questionnaires.

A detailed summary and the questionnaires are provided in Appendix I of this test report.

TABLE 8-I. HUMAN FACTOR FORM SUMMARY
FAVORABLE/UNFAVORABLE RESPONSES

QUESTION	RESPONSE(S) FAVORABLE	1st Quest.	2nd Quest.	UNFAVORABLE	1st Quest.	2nd Quest.
How do you feel about the TTS?	(*)	10	8	(**)	2	2
Would you recommend any changes to the TTS?	(No)	0	2	(Yes)	10	7
Do you feel there are any unsafe features about the TTS? Day? Night? Unusual weather conditions?	(No)	20	24	(Yes)	7	2
Do you feel the average operator will be able to operate with this system equally as efficient as with any other system?	(Yes)	4	1	(No)	6	7
Do you feel the average repairman will be able to troubleshoot and repair this system?	(Yes)	2	6	(No)	1	3
Do you feel that the average operator will be able to: Operate this equipment? Service this equipment? Remove and install this equipment?	(Yes)	6	22	(No)	0	5
Are gauges, dials, scales, and numbers adequate for clear vision during: Day operation? Night operation? Unusual weather conditions?	(Yes)	20	19	(No)	7	8
Do you feel that instructions, labels, and decals are adequate?	(Yes)	9	8	(No)	0	1
Do you feel that warning instructions, labels, and decals are adequate?	(Yes)	8	7	(No)	1	2

Notes:

(*) Favorable responses were:
- Very good
- Above average
- More than adequate

(**) Unfavorable responses were:
- Could use some minor changes
- Not very satisfactory
- Very poor

9.0 FIRING SHOCK AND ROAD VIBRATION TEST REPORT

9.1 BACKGROUND

The incorporation of the tank thermal sight into the M60A1 Weapon systems, requires the establishment of a baseline level for gun firing shock, hard surface/cross country road vibration. These levels are required to determine the design adequacy of the components and mounting bracketry used in the TTS system.

Testing, utilizing PQ-1 and -2, was conducted at Fort Knox during the week of 18 July 1977 to collect firing shock and road vibration data. The results of these tests are provided in detail in the Supplement Test Report, Gun Firing Shock and Road Vibration, dated 15 November 1977, printed under separate cover. The following paragraphs provide an abstract of the supplemental report.

9.2 TEST OBJECTIVES

The object of this test program was to evaluate the compatibility of the M60 series tank, with that of the installed components and bracketry of the TTS system, during the firing of the main gun, and a road imposed shock/vibration environment.

In order to ascertain these baseline compatibility levels a test program was required to determine the three axis magnitude of the imposed gun shock/road vibration environment at the following tank locations.

1. Base of the gunner's TTS periscope - response of gunner's scope.
2. TTS periscope head - response of periscope head.
3. Turret roof adjacent to gunner's periscope mounting - input to the gunner's scope.
4. Turret right wall, between commander's TTS light elbow mounting pads - turret wall input.
5. Flange on TTS light elbow - response to the turret wall input.
6. No-bak housing - input to TTS light elbow and the commander's viewer.
7. Commander's viewer mounting bracket - response to the no-bak mounting.
8. Turret bustle roof - input to TTS power converter.
9. Power converter housing - response to the TTS converter mounting.

9.3 CONCLUSIONS

1. All of the TTS interface vibration levels were below the TTS component vibration levels specified for TTS component qualification test.

2. Except for PQ-1 No-Bak/TTS light elbow interface, all gun shock levels were below the TTS component shock levels specified for TTS component qualification test. The discrepancy between PQ-1 and PQ-2 no-bak input level is unexplained. The PQ-1 no-bak real time gun shock signatures indicated the presence of high frequency data 1-2 KHz) that was not observed on the test firing on PQ-2. A possible explanation of this high frequency component noted on PQ-1 could have been, difference in vehicle component structure, component alignment and/or mounting methods (bolt torque). In subsequent check of vehicle logs, a loose ball joint bolt and image intensifier tube was reported on PQ-1 four days after the main gun firing tests.

9.4 TEST DISCUSSION

In both test phases, road vibration and gun shock, the test vehicle used were two fully functional M60A1 (P1) tanks with standard suspension with T-142 track, and incorporating the tank thermal sight system (TTS).

Road vibration testing (both hard surface, cross country) and main gun firing shock testing was accomplished at Fort Knox during PQT-C qualification test programs.

The instrumentation setup for the shock data is shown in figure 9-1. The gun firing shock acceleration data was recorded on magnetic tape, and then played back into an analog-to-digital converter and re-recorded on digital computer tape, for computer analysis. This data was digitized at 16KHz/sec for 128 milliseconds. To prevent aliasing in the digital signal, all channels of data were filtered prior to digitizing by a 2500 Hertz low pass filter. This digitized data was then processed as a shock response spectrum, and plotted as equivalent static acceleration (Max G's). For this analysis, the maximum spectrum using one percent damping, was computed at 40 frequency points corresponding to 15 to the decade. For every acceleration time trace, a shock response spectrum (ESA) was computed. Mean & mean + three standard deviations shock spectrum were computed for multiple round firing with same configuration (sensing axis and accelerometer location).

The two instrumented M60A3 vehicles used in the gun firing shock test, were also utilized for vibration testing. The instrumentation setup for both the hard surface and cross country vibration is shown in figure 9-1.

Data acquisition was accomplished while the vehicle operated under the following test conditions.

1. Paved Surface (PQ-1 and PQ-2)

   A. Constant speeds of 5, 10, 15, 20 and 25 mph

   B. 0-Max-0 mph acceleration/deceleration

2. Cross Country (PQ-2)

   A. Ten (10) minutes of variable speed operation

   *NOTE: Condition 1 was performed in both with and without the TTS commander display to determine the effects of the display on the No-bak housing vibration levels.

The resulting tape recorded data was processed using a spectral dynamics (Model SD330) real time analyzer to provide two (2) power spectra density plots for each speed/condition. The lower plot is an ensemble average for 32 seconds (64 averages) of real time. The upper plot is the maximum value (peak) obtained for this same 32 second sample. For the cross-country plots, the average time was increased to 256 seconds (512 averages) of real time.

Due to the volume of data, the presentation of the test results, for both shock and vibration, and analysis of those results are provided in the Supplement Test Report.

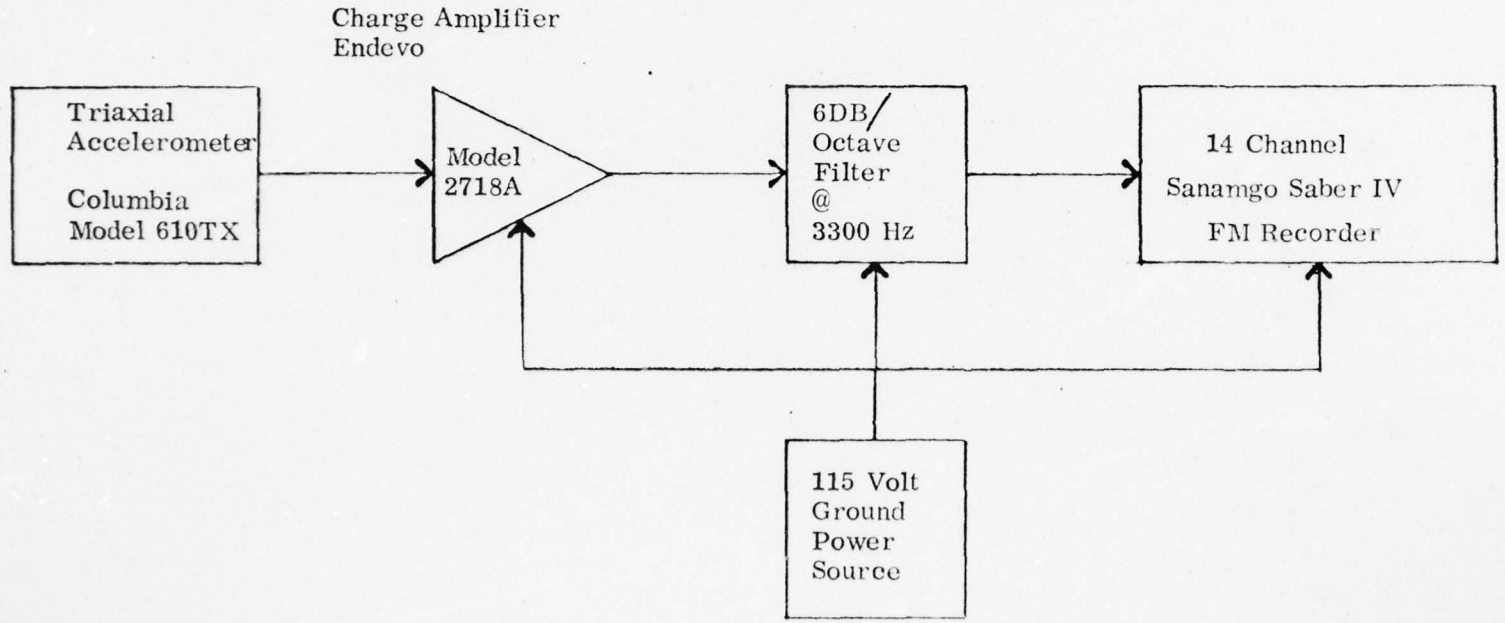

Figure 9-1. SHOCK INSTRUMENTATION DATA ACQUISITION SYSTEM

AD-A051 650 CHRYSLER CORP CENTER LINE MI WARREN DEFENSE DIV F/G 17/5
CONTRACTOR PROTOTYPE QUALIFICATION TEST (PQT-C) M60A1(PI) TANK --ETC(U)
DEC 77 R PAVER DAAK30-76-C-0005

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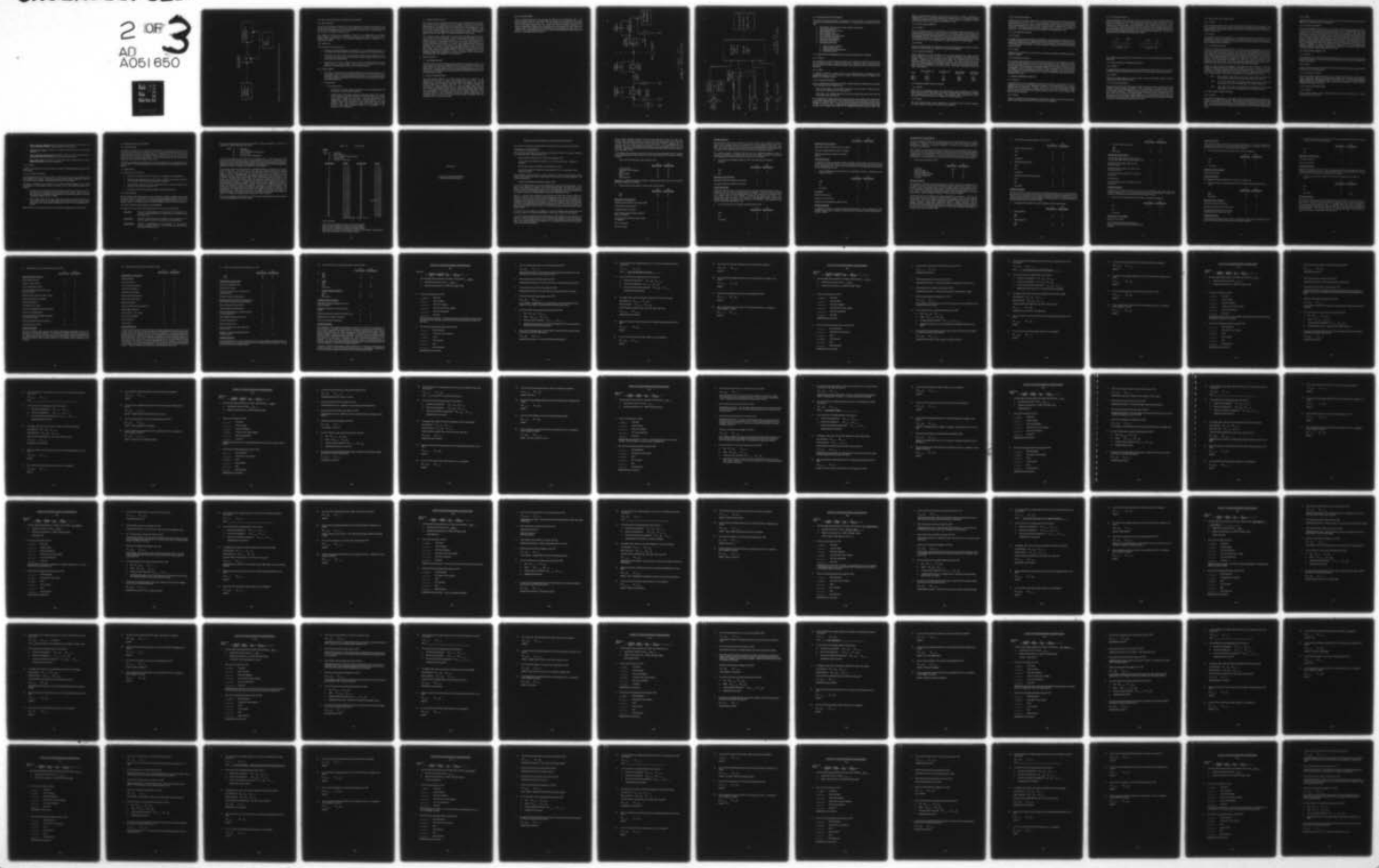
2 OF 3
AD A051 650

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650

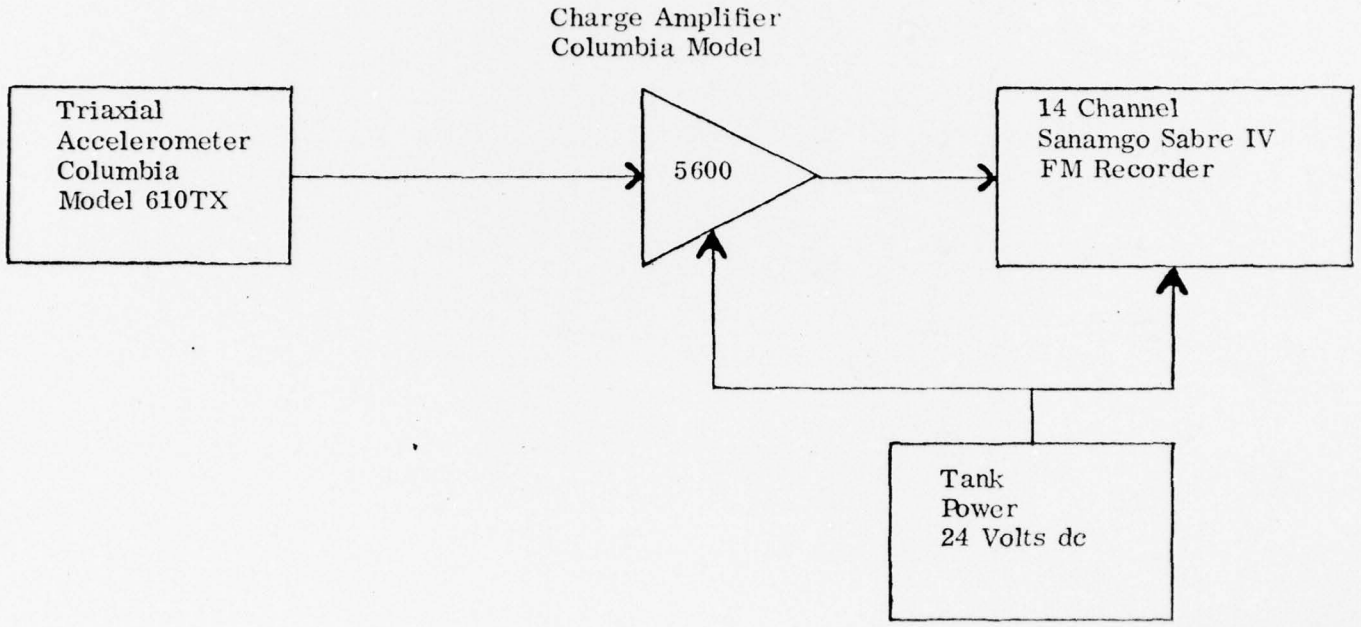


Figure 9-2. VIBRATION INSTRUMENTATION DATA ACQUISITION SYSTEM

10.0 EMC AND ELECTRICAL TRANSIENT TEST REPORT

10.1 BACKGROUND

The EMC and Electrical Transient Test were conducted at Fort Knox on tank PQ-1 upon completion of the PQT-C. The test had been scheduled for conduct on a facility tank but due to limited TTS hardware, the test was deferred to a PQT-C tank. The time frame for the test was 15 through 21 September 1977.

The results of the tests are provided in detail in the Supplement Test Report, Electromagnetic Compatibility and Electrical Transient Test, dated 15 November 1977, printed under separate cover. The following paragraphs provide an abstract of the supplemental report.

10.2 OBJECTIVE

The objectives of this program were:

1. Determine the Electromagnetic compatibility of the M60A1E3/TTS system by functioning the vehicle systems and observing anomalies in the TTS performance.

2. Determine the effect of the vehicle battery condition, on the operation of the TTS system, with the batteries at full charge, quarter charge, and then with the vehicle batteries disconnected.

3. Determine the time for a TTS silent watch, with the vehicle batteries at full charge, and at a quarter charge. Then determine the ability of the vehicle batteries to obtain an engine restart after this watch period.

10.3 CONCLUSIONS

1. EMC Test: The visual monitor of both the gunner's day and thermal sight and the commander's sight verified satisfactory operation of the TTS system while exercising various load switching functions and radio transmitting frequencies. The target signature presentation of the TTS system, for all operations was clear and without distortion.

2. Transient Test

   A. Visual Observations:

      1. Day Sight: The target signature presentation of the daylight sight was not affected by any transient conditions.

      2. Thermal Sight: Both sights provided momentary washout and a slight reticle and target image tilt whenever the hydraulic power pack and/or turret blower motors are activated. The observed anomaly was independent of engine operation and/or battery condition. The tilt condition remains for the duration of the power pack and/or motor operation cycle. This reticle and image tilt did not cause the TTS system to lose target boresight and was not a distraction in the operation of the TTS system.

B. Voltage Transients Levels:

The most severe low voltage transient occurred for the conditions of power pack and/or turret blower operation, with the engine idling and the batteries disconnected or the engine off with the batteries at a low charge state. For these conditions, the voltage input at the TTS power converter dropped to 13 vdc for the first condition and 13.5 vdc for the second. These negative going transients are of short duration (10 milliseconds) and returned to an acceptable supply level for the remainder of the power pack/blower motor cycle.

The next most severe transient was the result of the switching of the TTS system from standby to the on condition. This switching was reflected on both the voltage and the current measuring points. The current switching transient recorded indicated a momentary current surge to 35 amps, then returning to a normal TTS system current drain of 10 amps. The voltage recorded for this load switching was a sharp 5.0 vdc drop in the supply voltage to the TTS power converter, with a return to normal operating voltage (24 vdc) after the initial power surge. The above switching transients (worst case) were achieved with the battery disconnected and idling at 750 rpm. Both this transient and all other transients, which were considered to be minor in nature, did not visibly and/or functionally affect the operation of the TTS system.

3. Silent Watch Test:

A. Full Charge Batteries:

The silent watch on the full charge batteries lasted for a period of 9 hours. The vehicle under test obtained an engine restart at the completion of the nine hour watch period, with the specific gravity of the batteries still at a 50% of full charge level. This data indicates that the TTS system operating within a vehicle that has a set of batteries at the full charge state, would be able to perform an 8 hour silent watch mission.

B. Quarter Charge Batteries:

The silent watch testing on the vehicle battery system at a quarter of full charge, (with TTS laid on target) was performed for two hours. At the completion of this watch period, an engine restart was achieved. The specific gravity reading prior to engine restart was 1.125. The battery discharge was continued to a specific gravity level of 1.120, an engine restart was not accomplished at this specific gravity level. The vehicle batteries were allowed to rest for a period of one hour, at the end of this rest period an engine restart was accomplished. The specific gravity prior to engine restart was 1.125. Therefore, given the same conditions, TTS current, battery temperature, and cranking current, a two hour TTS silent watch mission is possible when the batteries are at a 25% state of charge.

10.4 TEST DISCUSSION

The test vehicle utilized for this test was the M60A1-P1 tank designated PQ-1. The current sensors/shunts, and the interconnecting cabling were installed into the vehicle wiring network as shown in Figure 10-1. The tank systems were operated in accordance with an established sequence and the voltage and current transients recorded. The received measurement signals were conditioned as shown in Figure 10-2 and recorded on magnetic tape. Data reduction was accomplished via oscillograph recordings. Due to the volume of data, the presentation of the test results and the analysis of those results are provided in the Supplement Test Report.

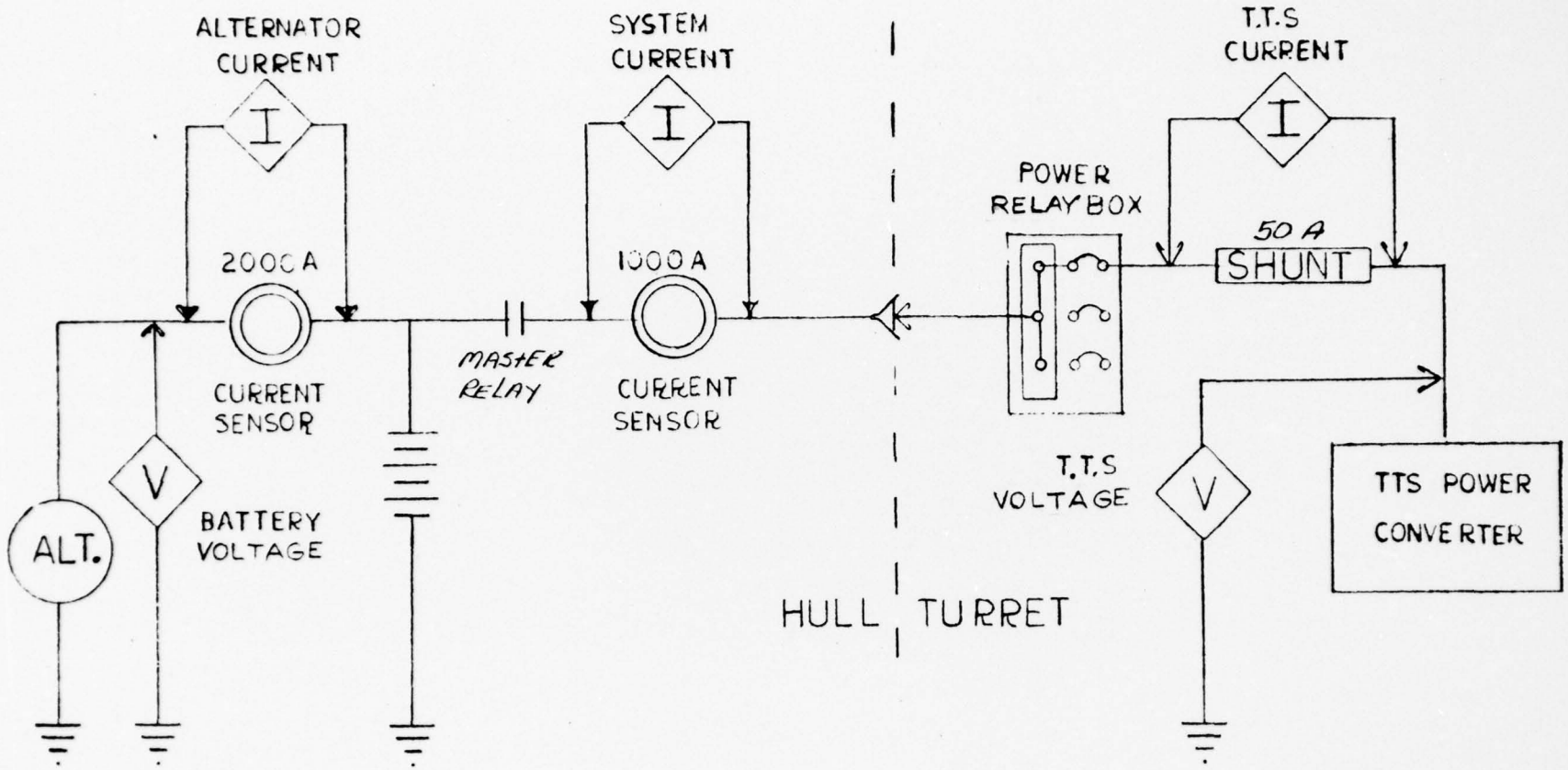


FIGURE 10-1
VEHICLE TEST POINTS

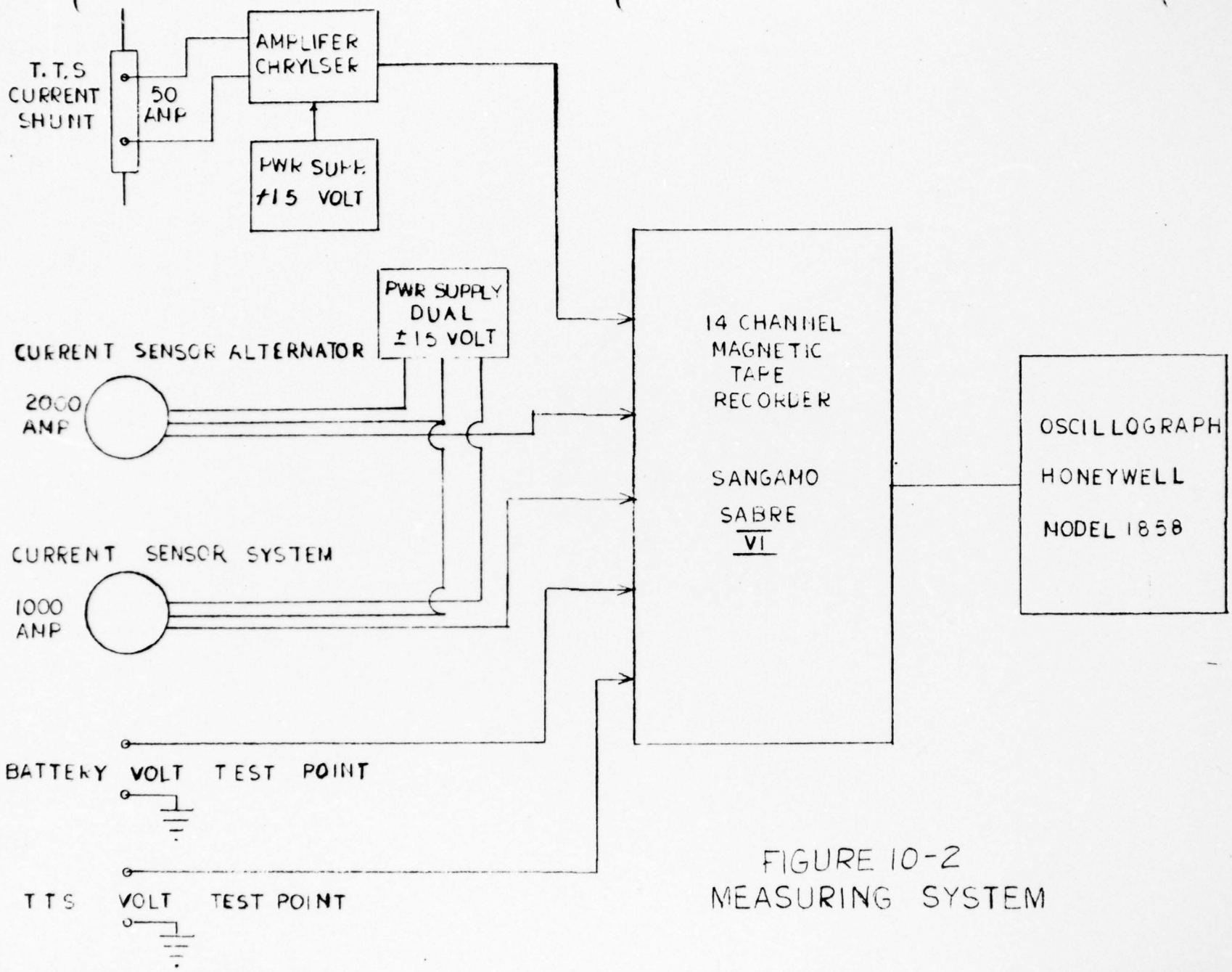


FIGURE 10-2
MEASURING SYSTEM

11.0 M60 HARDWARE IMPROVEMENT

The following improved hardware was subjected to test on M60A3 TTS Tanks during the Contractor Prototype Qualification Test (PQT-C). A separate report is presented for each item.

- o RISE Engine Transmission Oil Cooler Adapter and Gaskets
- o No-Bak Improvements
- o Engine Exhaust Outlet Covers
- o TLAC Special Filters
- o Shock Absorber Upper Pin
- o Final Hydraulic Powerpack Filter
- o New Track End Connector
- o Final Drive Venting System
- o Final Drive Torque Nuts
- o Auxiliary System Items

    1. Smoke Grenade Launcher
    2. Gunner's Heat Guard
    3. Ready Round Retaining System
    4. Spent Brass Guard

11.1 RISE ENGINE TRANSMISSION OIL COOLER ADAPTERS AND GASKETS

11.1.1 Preface

The transmission oil cooler adapter and gasket were modified to reduce the incident rate of oil leakage between the adapter and cooler. Successful results were previously achieved with the modified adapter and gasket during engine operation on a dynamometer test stand.

11.1.2 Object

To conduct a 4000-mile vehicle test with the modified adapters and gaskets at four designated locations on each TTS tank, visually examining condition of adapters and gaskets and if leakage occurred.

11.1.3 Procedure and Results

Prior to installing the powerplant in the hull, modified adapters and gaskets were installed in the following locations during buildup:

PQ-1 & PQ-2 tanks: Left and right transmission oil cooler inlet, transmission inlet left side and transmission outlet on right side.

PQ-3 Tank: Left and right oil cooler outlet and transmission outlet on left side and transmission inlet on right side.

No oil leakage was visible between the transmission oil cooler lines and the transmission or oil coolers during ground hop. After each powerplant was reinstalled in the hull, no oil leakage was evident. Each of three TTS tanks accumulated 1500 endurance miles during the PQT-C tests at Ft. Knox. During quarterly maintenance and when any powerplant was removed, no oil leakage was evident at the designated locations except on PQ-1 tank

where one incident was reported at 1021 test miles (ITR No. T-0182). Tightening the adapter bolts on the transmission remedied the leakage problem. The modified adapters and gaskets remained on the three TTS vehicles at Ft. Knox after completion of PQT-C tests for continued testing during the scheduled OT-II tests.

11.2 NO-BAK IMPROVEMENTS

11.2.1 Preface

Due to a long term history of malfunctions of the No-Bak mechanism within the turret traversing gearbox system, a series of product improvement ideas were developed and tested under controlled laboratory conditions. It was concluded from these development investigations that the most cost-effective solution to the slippage and seizing problems of the No-Bak would be to reduce its input torque loading by modifying the gear train ratios within the turret traversing gearbox to substantially reduce No-Bak loading.

11.2.2 Object

Verify the effectiveness and durability of the modified gearbox and No-Bak assembly during the proposed 4000-mile vehicle field operation test program.

11.2.3 Procedure and Results

During preparation of tanks for PQT-C tests, a modified gearbox and No-Bak assembly were installed in the three TTS tanks. No special maintenance was required during testing. Movement of the manual traverse handle was monitored when turret was operated in power mode with handle out of detent. The initial check in PQ-2 tank indicated handle movement but no additional incidents were reported during the PQT-C tests. The modified gearbox and No-Bak assemblies remained in the turret for scheduled OT-II tests after completion of the PQT-C tests. Turret data accumulated during the PQT-C tests follows:

Tank	Turret Power On Hrs.	Hyd Pump ON Hrs.	Turret Brake Actuations	Hyd Pump Actuations
PQ-1	322.2	2.3	Inop.	4439
PQ-2	273.3	4.4	3938	11512
PQ-3	323.6	Inop.	4797	1934

11.3 ENGINE EXHAUST OUTLET COVERS

11.3.1 Preface

Early tests on the exhaust outlet cover indicated the cover assembly was adversely affected by the exhaust temperature, resulting in warpage and/or weld failures. Changes were incorporated to stiffen the design. The proposed VECP removes parts of the structural material and may result in a repeat of the early problems.

11.3.2 Object

Test the improved outlet covers, fabricated in accordance with the VECP Proposal TP-G4895, during the 4000-mile vehicle field test program.

11.3.3 Procedure and Results

Improved outlet covers were installed on the right side engine exhaust during preparation of the tanks for the PQT-C tests. After completion of the PQT-C tests, which included durability mileage of 1500 miles, the improved engine exhaust flappers were satisfactory when visually checked for broken welds, warpage, general condition and freedom of movement. The exhaust elbows with the improved covers remained on the three TTS tanks at Ft. Knox for additional field testing during the scheduled OT-II tests.

11.4 TLAC SPECIAL FILTERS

11.4.1 Preface

An improved filter element design was developed by Chrysler Warren Defense Division's Powerplant Department, and released under Part No. SK-6142-080576, with the purpose to improve the effectiveness and durability of filter elements for the top loader air cleaners of the M60 series tank vehicles. A revised method of bonding the seal to the filter end cap was utilized.

11.4.2 Object

Validate the improved TLAC filter elements during the proposed TTS 4000-mile vehicle field test program.

11.4.3 Procedure and Results

The improved filter element frame end caps were painted blue and installed in the right air cleaners during preparation of three TTS tanks for PQT-C tests. During accumulation of more than 1500 miles by each of the three tanks during the PQT-C tests at Ft. Knox, normal preventive maintenance, consisting of cleaning the filter elements as required, was accomplished. After completion of the PQT-C tests, no damage to the filter elements was evident and the bond of each filter seal to the end cap was good. The improved TLAC filters remained in the three TTS tanks at Ft. Knox for additional field tests during the scheduled OT-II tests.

11.5 SHOCK ABSORBER UPPER PIN

11.5.1 Preface

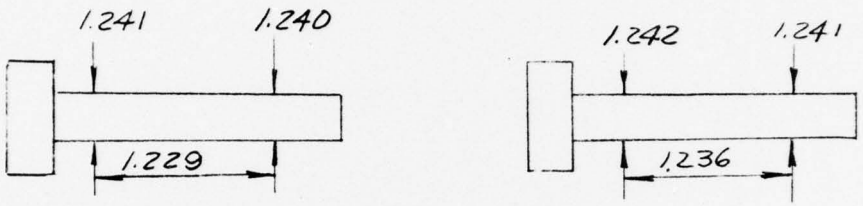
In response to a Ft. Lewis suggestion transmitted to CWDD by the M60TD-T office an Engineering Evaluation of the suggestion to replace the shock absorber pin with a bolted modified pin was conducted. Torquing the bolt to 175 ft-lbs should cause enough deflection of the upper bracket to make contact with the bearing. Installation of these pins in fielded test vehicles will provide empirical data to be used in solving shock absorber pin wear problem.

11.5.2 Object

Verify the proposed field modification to improve the clamping face of the upper shock absorber pins during the 4000-mile TTS vehicle field test program.

11.5.3 Procedure and Results

During preparation of three TTS tanks for the Ft. Knox PQT-C tests, three modified shock assembly mounting pins were installed in the upper bearing, attaching the shock to the hull mount on right side of tank. The threaded pins were torqued to 175 ft-lbs. After completion of 1500 endurance miles during PQT-C tests, torque on the bolts varied from 75 to 150 ft-lbs. Each pin was easily removed compared to the standard pins, with no physical damage evident, except some rust. Very little wear was noticeable. No problems were encountered during reinstallation of the pins, which were torqued to 175 ft-lbs. The upper shock pins from PQ-2 tank measured as follows:



The modified pins remained in the TTS tanks at Ft. Knox for evaluation during additional field tests.

11.6 FINAL HYDRAULIC POWERPACK FILTER

11.6.1 Preface

An experimental 5-micron filter has been recommended by FRH Task Force to keep the powerpack FRH fluid adequately clean to prevent valve gumming during field operations.

11.6.2 Object

Validate the effectiveness of a 5-micron filter to keep the hydraulic system FRH fluid contamination below specified limits.

11.6.3 Procedure and Results

During preparation of three TTS tanks for PQT-C tests at Ft. Knox, a 5-micron filter was installed in each hydraulic powerpack. After completion of the PQT-C tests, which included 1500 miles of durability at Ft. Knox, a sample of FRH oil was taken from each of the hydraulic reservoirs. Contamination analysis determined that the specimen of oil from tanks PQ-1 and PQ-3 met specifications. In the oil sample from PQ-2 tank, the particles in the 15 to 50-micron range, appearing to be sand, were too numerous to count. No remedial action was taken. The 5-micron filters remained in the tanks for continued testing at Ft. Knox during the scheduled OT-II tests.

11.7 NEW TRACK END CONNECTORS

11.7.1 Preface

Due to excessive localized wear of the present track end connectors, the currently used heat treatment process was modified to obtain an increased surface hardness in the critical areas of the connectors, and thereby reduce its wear and improve its effective utilization life cycle.

11.7.2 Object

The purpose of the vehicle evaluation is to determine the life of end connectors with hardened wear surfaces. Assuming there is a significant increase in life for the hardened end connectors when compared to the present end connectors, hardened end connectors will be released for the T142 track.

11.7.3 Procedure and Results

The three TTS tanks prepared for PQT-C tests used a mixed configuration of track end connectors installed on the BART T142 track. Tank PQ-1 had all standard end connectors while tank PQ-3 all induction hardened. Tank PQ-2 used 80 standard end connectors in new condition and 80 new induction hardened connectors, identified with an "0" stamped on each side, installed as groups on the inside and outside of 40 consecutive track sections. Wear on induction hardened and standard end connectors on all three TTS tanks was measured and recorded after completion of 1500 mile endurance of PQT-C tests. Suspension Dept. has the data. Due to lost, damaged, replaced and reused end connectors required for maintenance of the track, the data is considered inconclusive.

During the tank refurbishment program preceeding the OT-II testing the following hardware combinations were assembled and installed on the three test tanks for further evaluation. All tank components were torqued to specified values. Thorough inspection and removal of sample components will be performed at the conclusion of OT-II testing after a visual inspection of the track and suspension at a convenient mid-test point.

- o PQ-1 New standard T142 track on left side. New T142 track with used hardened end connectors and improved centerguides on right side.
- o PQ-2 New T142 track with used hardened end connectors and improved centerguides on left side. Standard new T142 track on right side.
- o PQ-3 New T142 track with new hardened end connectors and improved centerguides on left side. Standard new T142 track on right side.

11.8 FINAL DRIVE VENTING SYSTEM

11.8.1 Preface

The positive venting system of the M60A1 final drives was developed to eliminate gas pressure buildup within the final drive housing during prolonged vehicle operations in high ambient temperature environments. This venting system consists of two plastic tube lines: one interconnection line between the left hand and right hand final drive housing, and a vent line from the left hand final drive housing to the left hand air cleaner inlet elbow.

11.8.2 Object

Validate the final drive venting system's performance and durability during the proposed 4000-mile vehicle field operation test program.

11.8.3 Procedure and Results

While the powerplant was removed from each of three TTS tanks being prepared for PQT-C tests at Ft. Knox, plastic tubes interconnecting the left and right hand final drive assemblies to the left hand air cleaner inlet elbow were installed. After PQ-2 tank accumulated 324 test miles during the PQT-C tests, it was observed that the plastic line from the tee to the left air cleaner elbow shrunk due to heat from the engine exhaust pipe, preventing venting of both final drives. The damaged portion of the plastic line was replaced. ITR No. T-0054 recommends relocation of the line to prevent heat damage or possible damage during installation/removal of the powerpack. After completion of 1500 test miles during PQT-C tests, the venting system was satisfactory when inspected for leakage or damage to tubing, deformation of tubing due to heat and loose/missing attaching hardware. The positive venting system remained in the three TTS tanks at Ft. Knox for evaluation during the scheduled OT-II tests.

11.9 FINAL DRIVE TORQUE NUTS

11.9.1 Preface

The pinion gears of the M60A1 final drive assemblies fail due to excessive spalling of gear teeth contact surfaces. An improved torque nut design was developed and is proposed for release to production.

11.9.2 Object

Verify the effectiveness of the improved final drive torque nuts during the proposed 4000-mile vehicle field testing program.

11.9.3 Procedure and Results

The three available improved torque nuts were installed in final drives of TTS tanks as follow: right side of PQ-2 tank and both sides of PQ-3 tank. No special monitoring was required during the 1500 endurance miles of the PQT-C tests. With no failure incidents experienced during the vehicle field tests, the final drives remained on the test tanks for scheduled OT-II tests at Ft. Knox.

11.10 AUXILIARY SYSTEM ITEMS

11.10.1 Preface

The following auxiliary systems product-improved items were scheduled to be tested during field tests at Ft. Knox.

- o Smoke Grenade Launcher concept presently incorporated in the M60A1 P.I. turret mockup and featuring wiring through the turret casting.

- o Gunner's Heat Guard to protect the gunner's legs from the hot powerpack reservoir.

- o Ready Round Retaining System integrated with the turret basket screen to prevent the ready rack from interfering with the turret motion.

- o Spent Brass Guard to prevent the spent shells from rolling around the turret basket and interfere with turret operations.

11.10.2 Object

Validate the effectiveness of the PI hardware during the proposed 4000-mile vehicle field test program.

11.10.3 Procedure and Results

During preparation of the three TTS tanks for PQT-C tests at Ft. Knox, the above items were installed in the tanks. Although the smoke grenade launcher integration hardware and bracketry were installed, the grenade launchers were not available.

No special monitoring was required on the above product-improved items during accumulation of 1500 endurance miles of the PQT-C tests. The following incidents were reported:

- o The gunner's heat guard was removed to permit repair work in the turret of PQ-3 tank and was not reinstalled at the completion of the repair. When turret was traversed, the loose guard jammed between the hull and turret basket, sustaining irrepairable damage (ITR No. T-0234).

- o The forward screen of the spent brass guard in PQ-1 and PQ-3 tanks hit the 105mm ammo racks due to weld failure of mounting bosses on the turret floor. Weld repairs were made during refurbishment of the tanks for the scheduled OT-II tests.

Effectiveness of the PI hardware will be evaluated after completion of the OT-II tests.

12.0 SURVEILLANCE TEST REPORT

12.1 BACKGROUND

A subjective evaluation of the acquisition capability of the TTS system was conducted at Fort Knox during the week of 8 August 1977. The test was based upon the NVL test plan which provided a method of limits and subjective acquisition test. The NVL test plan was modified by NVL and the Armor Board in order to perform the test in a five day time frame and within the facility restrictions. The test was performed at MFO tank gunnery range which has a maximum range of 2000 meters.

The results and analysis are provided in a classified supplement test report published under separate cover. The following paragraphs provide an abstract of the supplemental report content.

12.2 OBJECTIVES

The objectives of the test were:

a. Determine the range limitation for detection, recognition and identification.

b. Determine the capability of the TTS system to detect and recognize targets at random ranges under available environmental conditions.

c. Determine the effects of service ammunition blast on thermal image and the ability to sense a tracer round with TTS.

d. Determine if there are any display image interpretation problems.

12.3 CONCLUSIONS

The tank thermal sight based upon the test limitations in range and target sample meets the requirements. In comparison to the day sight under daylight conditions the thermal channel is within 4 percent of the detection/recognition/identification of that of the daylight channel. No adverse effects were noted during the firing of service ammunition.

12.4 TEST METHOD, PROCEDURE, AND DISCUSSION

The definition of the level of discrimination used in this test are defined below:

Detection: Visual act corresponding to the perception of the presence of a potential military target based on target intensity, unnatural shape, movement, etc.

Recognition: Visual act corresponding to the perception of the general class of military targets, e.g., tracked vehicles vs. wheeled vehicles.

Identification: Visual act corresponding to the perception of the particular members of specific classes of military targets, e.g., M60 tanks vs. T54 tanks vs. M48 tanks, etc.

The level of discrimination greater than detection is being investigated. A total of five targets were utilized during the test and are:

Target	A	-	M60 tank
	B	-	M551 Sheridan
	C	-	M113 Armored personnel carrier
	D	-	5/4 ton truck
	E	-	M151A1 1/4 ton truck (jeep)

A total of ten observers were used for the surveillance test. A total of sixty runs were made with each tank, giving a total of 180 observations (see table 1). All observers were trained on both the tank thermal sight operation and thermal target signature recognition. Additional training was required to familiarize the test observers with the test procedures themselves in order to maximize the efficiency of the program.

The complete target set was stationed in a defilade position at the far end of the range from the observers. The initial set of observers was stationed behind their assigned sensors. Once everyone was in position, the command for the first target to start up range was given. Simultaneously, the observers were given the command to begin watching. The speed with which the target vehicle approached the observers was less than 10 MPH so that the targets speed was no clue. The distance from the targets to the sensors was monitored at all times sothat the range was recorded whenever one of the observers gave a response. A transponder was attached to each target with the receiver providing input to a scoring computer. As each observer gives a response, the distance in meters as displayed by radar, was recorded. The order of target presentation was randomized so that the observers probability of guessing the target was reduced. Once the observers have discriminated the targets with regards to detection, recognition and identification, the target was sent back to the staging area and the next target was started up range. The observers were told to attempt to discriminate the targets into classes. The sequence of targets and observers can be seen in table 1.

Due to the confidential classification of the test results, this information is summarized in the classified supplement to this test report.

Table 12-1. TARGET LIST

Legend

Target A - M60 Tank
B - M551 Sheridan
C - M113 Armored Personnel carrier
D - 5/4 Ton Truck
E - M151A1 1/4 Ton Truck

Run Number	Target	Run Number	Target
1	A 1, 3, 5	31	C 1, 3, 5
2	E 1, 3, 5	32	D 1, 3, 5
3	C 1, 3, 5	33	A 1, 3, 5
4	D 1, 3, 5	34	E 1, 3, 5
5	B 1, 3, 5	35	B 1, 3, 5
6	D 2, 4, 6	36	D 2, 4, 6
7	A 2, 4, 6	37	E 2, 4, 6
8	E 2, 4, 6	38	B 2, 4, 6
9	C 2, 4, 6	39	C 2, 4, 6
10	B 2, 4, 6	40	A 2, 4, 6
11	C 1, 3, 5	41	D 1, 3, 5
12	A 1, 3, 5	42	C 1, 3, 5
13	E 1, 3, 5	43	B 1, 3, 5
14	B 1, 3, 5	44	A 1, 3, 5
15	D 1, 3, 5	45	E 1, 3, 5
16	B 2, 4, 6	46	C 2, 4, 6
17	C 2, 4, 6	47	D 2, 4, 6
18	A 2, 4, 6	48	A 2, 4, 6
19	E 2, 4, 6	49	E 2, 4, 6
20	D 2, 4, 6	50	B 2, 4, 6
21	E 1, 3, 5	51	RUN VOIDED
22	B 1, 3, 5	52	C 1, 3, 5
23	D 1, 3, 5	53	A 1, 3, 5
24	A 1, 3, 5	54	E 1, 3, 5
25	C 1, 3, 5	55	D 1, 3, 5
26	A 2, 4, 6	56	F 2, 4, 6
27	B 2, 4, 6	57	B 2, 4, 6
28	D 2, 4, 6	58	D 2, 4, 6
29	E 2, 4, 6	59	A 2, 4, 6
30	C 2, 4, 6	60	C 2, 4, 6
	Add on run #126 - Troops - 2, 4, 6		

EXPLANATION:

Runs # 1-25 are daylight runs using the Thermal Channel.
Runs # 26-50 are night runs using the Thermal Channel.
Runs #51-60 are daylight runs using the Daylight Channel.
Run #126 was an add on to assess ability to observe troop target. It took place at night and was observed thru the Thermal Channel.

APPENDIX I

HUMAN FACTORS ENGINEERING QUESTIONNAIRE SUMMARY

HUMAN FACTORS ENGINEERING QUESTIONNAIRE SUMMARY

The human factors engineering questionnaire answers have been summarized as follows:

TTS Operation - Physical Effects

Four questions were related to the effects of operating the TTS on the physical condition of the tank crewmen. These questions were:

> Did you feel any discomforts or strains while using the TTS?
>
> Do you feel that prolonged operation of the TTS would result in fatigue or eyestrain?
>
> Did you feel eyestrain or fatigue while operating the TTS?
>
> Did you feel any after-effects from operating the TTS, i.e., headaches, vision, fatigue or strains?

These questions were preceded by a control question to insure that any physical effect reported was actually the result of operating the TTS and not an existing condition. The control question was:

> How did you feel physically before using the TTS?

On the first questionnaire, all crewmen reported that they felt "extremely good," "very good in most respects," or "good." On the second questionnaire, the results were similar except that one crewman reported that he felt "not very good." However, this appeared to have no effect on his answers, since on the second questionnaire he answered NO to all four questions related to feeling physical effects from operating the TTS.

Nine of 11, or 82%, of the crewmen answered YES to at least one of the four questions. However, three of these crewmen in their explanations of the discomforts, strains, etc. referred to manual traverse handle location, cryogenic cooler noise and the difficulty of reaching and/or operating some controls. If these three responses are considered non-responsive to the question and not counted, then six out of eight, or 75%, of the crewmen felt some detrimental physical effect from operating the TTS. If the three responses are counted as NO answers, then six out of 11, or 56%, of the crewmen felt some detrimental physical effect.

No matter how the responses are analyzed, it must be concluded that operating the TTS resulted in some form of physical discomfort or strain for a majority of the crewmen.

The most common physical effect of operating the TTS reported by the crewmen was eyestrain. This was reported by six out of 11 (56%) of the crewmen. Two of the crewmen who did not report feeling eyestrain did not use the sight before the first questionnaire. Since they reported nothing to the contrary, it was assumed that they did use the sight before the second questionnaire.

Three crewmen reported eyestrain from day sight viewing and three from night sight viewing. None reported eyestrain from both day and night sight viewing. This, along with the fact that five crewmen did not report feeling any eyestrain, suggests that the eyestrain may be at least partly due to imperfect vision. It is recommended that all personnel who will be operating the TTS be given an eye examination prior to first TTS operation. Operators with imperfect (faulty) vision should wear properly fitted eyeglasses when operating the TTS.

The following control question was asked to insure that any discomfort noted in response to the following question was actually the result of operating the TTS, and not an existing condition.

How did you feel physically before using the TTS?

	1st Questionnaire	2nd Questionnaire
Extremely good	2	3
Very good in most respects	3	3
Good	5	2
Not very good	0	1
Poor	0	0
Extremely poor	0	0

Responses to questions related to affects of operating the TTS on the tank crewmen's physical conditions are as follows:

1. Did you feel any discomforts or strains while using the TTS?

	1st Questionnaire	2nd Questionnaire
YES	6	6
NO	4	3

Explanations and Comments

Manual traverse handle is too close to sight	1	2
TTS difficult to keep in focus	2	0
Cryogenic cooler is too loud	0	1
Night channel caused eyestrain, blurred vision or headache	2	2
Day sight caused eyestrain, blurred vision or headache	1	1
Felt no discomfort	2	4
Did not use sight	1	0

Analysis/Evaluation

The discomforts and strains reported by the tank crewmen were eyestrain, headache, blurred vision, scraped knuckles and annoyance from the cryogenic cooler noise. The Night Vision Laboratory and Texas Instruments are studying methods to decrease cooler noise. The manual traverse handle has been relocated and preliminary tests indicate that the handle can be rotated with one or both hands without scraping the knuckles.

The eyestrain problem (including blurred vision and headache) probably cannot be eliminated altogether, but insuring that crewmen with eyesight problems wear properly fitted eyeglasses should alleviate eyestrain problems to some extent.

2. Do you feel that prolonged operation of the TTS would result in fatigue or eyestrain?

	1st Questionnaire	2nd Questionnaire
YES	6	4
NO	4	5
Explanations and Comments		
Night sight would cause fatigue or eyestrain	4	0
Day sight would cause fatigue or eyestrain	3	1

Analysis/Evaluation

In general, experience with the TTS system did not change crewmen's attitudes about the probability that the TTS would cause fatigue or eyestrain. Only one crewman changed from a YES to a NO, and none changed from NO to YES. This could be an indication that some people's eyes are more subject to eyestrain and fatigue than others. Eye examinations should be given to all crewmen on TTS-equipped vehicles to determine whether eyeglasses are required. If a crewman is determined to need eyeglasses, they should be worn while operating the TTS.

3. Did you feel eyestrain or fatigue while operating the TTS?

	1st Questionnaire	2nd Questionnaire
YES	5	3
NO	3	6
No Answer	2	0

	1st Questionnaire	2nd Questionnaire
Explanations and Comments		
Night sight viewing caused eyestrain or fatigue	2	1
Day sight viewing caused eyestrain or fatigue	3	1
Sight not specified but eyestrain or fatigue reported	1	1

Analysis/Evaluation

A significant number of responses indicated a problem with eyestrain may exist in the use of both the day and night channels. Eye examinations should be given to all personnel who will be operating the TTS. If a crewman is determined to need eyeglasses, they should be worn while operating the TTS.

4. Did you experience any after-effects from operating the TTS, i.e., headaches, vision, fatigue or strains?

	1st Questionnaire	2nd Questionnaire
YES	3	3
NO	6	6
No Answer	1	0

Comments:

Experienced eyestrain	3
Fatigue from noisy motor	1
Headache from prolonged day sight viewing	1

Analysis/Evaluation

A significant number of people experienced after-effects from operating the TTS, although a large majority reported no after effects (see section titled "TTS Operation - Physical Effects").

TTS Operation - Mission Success

The basic measure of human factors effectiveness is the achievement of mission success through the integration of the operator/repairmen into the TTS system to achieve effectiveness, simplicity, efficiency, reliability, and safety of TTS system operation, training and maintenance.

The responses to each question affecting mission success are summarized in this section. The first part of each summary states the question and gives the crewmen's responses during the test (1st questionnaire) and at the completion of the test (2nd questionnaire). "Explanations and Comments" are crewmen's comments taken from the completed questionnaires. Analysis/Evaluation are comments by the CWDD human factors analyst.

1. How do you feel about the TTS?

	1st Questionnaire	2nd Questionnaire
Very good	10	7
Above average	0	1
More than adequate	0	0
Could use minor changes	2	2
Not very satisfactory	0	0
Very poor	0	0

Analysis/Evaluation

This indicates a very high level of satisfaction with the TTS. On the first questionnaire all 10 subjects rated the TTS very good, although 2 subjects added that it could use minor changes. On the second questionnaire 7 out of 9 subjects rated the TTS very good. One of the 7 added that it could use minor changes. One subject who had rated the TTS "very good" on the first questionnaire changed his rating to "more than adequate" on the second questionnaire. Another changed his rating to "could use minor changes."

No subjects felt that the TTS was "not very satisfactory" or "very poor." Note that the lowest rating used by any subject, "could use minor changes," does not have negative connotations. The written comments contain very positive words such as "best," "good," "easily," "accurate," "very good," "capability," "better," "easier," "quickly." The one negative comment, "tearing your knuckles off" referred to scraping the knuckles against the TTS reticle knob guards when operating the manual traverse handle and was made by a crewman who felt "very good" about the TTS. CWDD has eliminated this problem by relocating the manual traverse handle.

2. Do you feel the average operator will be able to:

		1st Questionnaire	2nd Questionnaire
a.	Operate this equipment?		
	YES	2	9
	NO	0	0
	No Answer	8	0
b.	Service this equipment?		
	YES	3	5
	NO	0	4
	No Answer	7	0
c.	Remove and install this equipment?		
	YES	1	8
	NO	0	1
	No Answer	9	0

Analysis/Evaluation

The fact that most crewmen who did not answer these questions on the first questionnaire did answer them on the second could be an indication that additional experience with the TTS gave them confidence in their ability to evaluate the system. The answers on the second questionnaire are another example of the high level of satisfaction (approval) expressed by the crewmen towards the TTS.

3. Are gauges, dials, scales and numbers adequate for clear vision during:

		1st Questionnaire	2nd Questionnaire
a.	Day operation?		
	YES	8	7
	NO	2	2
b.	Night operation?		
	YES	6	6
	NO	4	3

	1st Questionnaire	2nd Questionnaire
c. Unusual weather conditions?		
YES	6	6
NO	1	3
No Answer	3	0
Explanations and Comments		
The TSS night sight knobs are hard to read at night; dome light does not illuminate that area	2	0
Boresight knobs on night sight are in an awkward position	1	1
Operator must look away from sight to find some adjustments	0	1
All reticle knobs are difficult to see because of location	0	1
Not during fog	0	1
All dials, gauges, scales and numbers are very accessible	0	1

Analysis/Evaluation

In general, the responses indicated a high level of satisfaction with dials, scales and numbers, although six of the comments were related to the difficulty of seeing knob markings, indicating the desirability of improvement in this area.

4. Do you feel that warning instructions, labels, and decals are adequate?

	1st Questionnaire	2nd Questionnaire
YES	8	7
NO	1	2
No Answer	1	0
Explanations and Comments		
Should be more visible	0	1
Cannot traverse manual traverse handle without tearing your knuckles off (warning decal required)	1	1

Analysis/Evaluation

The responses indicate satisfaction with warning instructions, etc. This must apply to the vehicle since the TTS has no such warning instructions, labels and decals. It does have indicator lights and built in test equipment (BITE) displays.

5. Do you feel that instructions, labels, decals, etc. are adequate?

	1st Questionnaire	2nd Questionnaire
YES	9	8
NO	0	1
No Answer	1	0
Explanations and Comments		
Should be more visible	0	1

Analysis/Evaluation

The responses indicate satisfaction with instructions, labels, etc.

6. Must any attention be directed away from the target during adjustments of the TTS?

	1st Questionnaire	2nd Questionnaire
YES	1	1
NO	7	8
No Answer	2	0
Explanations and Comments		
Field of view knob hard to reach	1	0
Boresight adjustment knobs hard to get to	0	1
The gunner doesn't have to refer to any (adjustments); the TC gets the range	0	1

Analysis/Evaluation

A high level of satisfaction with the TTS is indicated here, with only one crewman (not the same one) answering YES to this question on each questionnaire.

7. Do you feel that the average operator will be able to operate with this system equally as efficient as with any other system?

	1st Questionnaire	2nd Questionnaire
YES	10	9
NO	0	0

Explanations and Comments

With proper training	5	3
Very easy to operate	1	0

Analysis/Evaluation

Apparently the crewmen felt that they were being asked if the average operator would be capable of operating the system. They all answered this question affirmatively, although some qualified it by stating that training would be required.

8. Do you feel the average repairman will be able to troubleshoot and repair the system?

	1st Questionnaire	2nd Questionnaire
YES	2	6
NO	1	3
No Answer	7	None

Analysis/Evaluation

This question merely gives the crewmen's general feeling about the TTS. On the first questionnaire, most crewmen did not answer the question. On the second questionnaire, 67% of the crewmen answered that the average repairman would be capable of troubleshooting and repairing the TTS, an indication of the high level of satisfaction usually expressed by the crewmen towards the TTS (see section titled "Favorable/Unfavorable Responses"). This question calls for an opinion--the answer is not based on experience of repair at higher levels of maintenance.

9. What features did you dislike most about the TTS?

	1st Questionnaire	2nd Questionnaire
Explanations and Comments		
Noisy cooldown motor	9	3
Location of FOV control	6	1
Has no rangefinder readout	1	0
Contrast, brightness and reticle knobs move too freely	2	1
Manual traverse handle too close to sight	4	5
Reticle adjustment was difficult	1	0
Browpads inadequate	1	0
No headrest on TC sight	1	1
Location of brightness and contrast knobs	0	1
Location of boresight knobs	1	2
Most refocus after switching from gunner to TC and vice versa	1	0
TTS did not operate well in heavy fog	0	1
Cooldown takes too long	0	1

Analysis/Evaluation

The noisy cooldown motor was the most disliked TTS feature, mentioned by 9 out of 10 operators on the first questionnaire. The second most disliked feature was the location of the field of view control, mentioned by 6 out of 10 operators on the first questionnaire. Also, highly disliked was the manual traverse handle location, which is a feature of the TTS/tank interface rather than the TTS itself. The manual traverse handle has been relocated.

10. What features did you like best about the TTS?

	1st Questionnaire	2nd Questionnaire
Explanations and Comments		
Biocular display	5	0
Wide/narrow FOV	3	2
Panel-mounted focus knob	2	0
Contrast knob location	0	1
Brightness knob location	0	1
White hot/black hot feature	1	2
Built-on filter (day sight)	1	0
Night sight display	1	1
Can see through smoke and light fog	0	2
Quick target acquisition	1	0
Good visibility - day or night	0	1
All controls accessible	1	0
Did not use sight	2	0
No comments	0	1

Analysis/Evaluation

The best liked features about the TTS were the biocular display and the wide/narrow field of view feature. The fact that biocular display was mentioned five times as the best-liked feature on the first questionnaire and not even mentioned on the second questionnaire probably indicates a feeling on the part of the operators that they should not mention the same feature twice, rather than indicating a dissatisfaction with the biocular display with longer experience. This is borne out by the fact that two of the three people who liked the field of view feature on the first questionnaire did not mention it on the second questionnaire. The third person who liked the FOV feature on the first questionnaire did not participate in the second questionnaire. Only one person did not have a "best-liked" feature -- another indication of the high level of satisfaction with the TTS.

11. Would you recommend any changes to the TTS?

	1st Questionnaire	2nd Questionnaire
YES	10	7
NO	0	2

Explanations and Comments

Silence the cooldown motor	6	1
Relocate FOV handle	5	1
Place protective covers on contrast and brightness knobs	2	0
Relocate manual traverse handle	6	2
Replace brightness, contrast, brightness and focus knobs, by knobs that lock in position	1	2
Move reticle knob to side of TTS	1	0
Improve night channel eye guard	2	1
Move all reticle knobs to a central location for easy adjustment	0	1
Move brightness and contrast knobs	1	0
Provide headrest for TC	2	0
Shorter cooldown time	1	0
Remove material from lower right hand corner of TTS	2	1
Relocate or redesign boresight knobs for daylight channel	1	0

Analysis/Evaluation

The recommendations are fairly consistent with the most disliked features noted in the previous question. The manual traverse handle is now being relocated by CWDD. This will eliminate the skinned knuckles problem.

12. Do you feel there are any unsafe features about the TTS?

	1st Questionnaire	2nd Questionnaire
a. Day		
YES	4	1
NO	6	8
b. Night		
YES	3	0
NO	7	8
No Answer	0	1
c. Unusual weather conditions		
YES	0	1
NO	7	6
No Answer	3	2
Explanations and Comments		
Inadequate protection against head or eye injury for gunner	2	0
Inadequate clearance for manual traverse handle	4	1
Inadequate protection against head injury for TC	4	0
Eyeguard boot for gunner's eyepiece	1	0
TTS is less effective in thick fog	0	1

Analysis/Evaluation

The responses in this question concerning the safety of the TTS were inconsistent. In several instances, responders checked NO and then gave an example of an unsafe feature. For example, responder #5 checked NO for all three conditions (day, night, unusual weather conditions) and then under "Explanations/Comments" wrote "Manual traverse handle clearance," (resulting in skinned knuckles), an unsafe feature that applies to day, night and unusual weather conditions operation. Aside from a comment that the "TTS is less effective in thick fog," (a comment that can be considered unresponsive to the question) all other comments concerned potential injury to operators because of inadequate manual traverse, handle clearance and inadequate head/eye protection because of poorly designed or non-existant browpads/eyeguards.

It should be noted that the problem of skinned knuckles due to hitting the hand against the reticle knob guard is a tank/TTS interface problem and not a TTS problem. This problem has been eliminated through the relocation of the manual traverse handle.

HUMAN FACTORS ENGINEERING QUESTIONNAIRE

TTS

Operator's

Nickerson	Lawrence	E.	E5
(Last)	(First)	(MI)	(Grade)

1. Previous night firing experience with night vision device(s) None

   a. Approximate number of hours N/A

   b. Explain circumstances (i.e., M60A1 (PI) night firing)

2. How do you feel about the TTS?

   X Very good

   _____ Above average

   _____ More than adequate

   _____ Could use some minor changes

   _____ Not very satisfactory

   _____ Very poor

   Explanations and comments: I think good because it could replace the sheake light and you don't have anything to give you away as easily; and also you can spot targets easy.

3. How did you feel physically before using the TTS?

   _____ Extremely good

   _____ Very good in most respects

   X Good

   _____ Not very good

   _____ Poor

   _____ Extremely poor

   Explanations and comments:

4. Did you feel any discomforts or strains while using the TTS?

Yes __X__ No _____

Explanations/comments: The focus knob doesn't focus good enough and the noise and the way the wide and narrow field of view is.

5. What features did you like best about the TTS?

Explanations/comments: The way you don't have to reach for your focus knobs.

6. What features did you dislike most about the TTS?

Explanations/comments: The noise; where the wide field of view is located.

7. Would you recommend any changes to the TTS?

Yes __X__ No _____

If yes, explain: Change where your manual handle is and the wide field of view handle is. Try to make it more quiet and it takes too long to cool.

8. Do you feel there are any unsafe features about the TTS?

a. Day Yes __X__ No _____

b. Night Yes _____ No __X__

c. Unusual weather conditions Yes _____ No _____

d. Explanations/comments: It should be something for the cover commander's sight so you could see during the day.

9. Do you feel the average operator will be able to operate with this system equally as efficient as with any other system?

Yes __X__ No _____

Explanations/comments: Yes, once they have learned about it.

10. Do you feel that the average repairman will be able to troubleshoot and repair this system?

Yes _____ No X

Why? Not until they learn the system.

11. Do you feel that the average operator will be able to:

a. Operate this equipment? Yes X No _____

b. Service this equipment? Yes _____ No X

c. Remove and install this equipment? Yes X No _____

Explanations and comments:

12. Are gauges, dials, scales, and numbers adequate for clear vision during:

Day operation? Yes _____ No X

Night operation? Yes _____ No X

Unusual weather conditions (e.g., rain, snow, sleet, fog, etc)?

Yes _____ No _____

Explanations and comments:

13. Must any attention be directed away from the target during adjustments of the TTS?

Yes _____ No X

Explain:

14. Do you feel that instructions, labels, decals, etc., are adequate?

Yes X No _____

Explain:

15. Do you feel that warning instructions, labels, and decals are adequate?

Yes X No _____

Explain:

16. Do you feel that prolonged operations of the TTS would result in fatigue or eye strain?

Yes _____ No X

Explain:

17. Did you feel any fatigue or eye strain while operating the TTS?

Yes _____ No X

Explain:

18. Did you experience any after-effects from operating the TTS, i.e., headaches, vision, fatigue, or strains?

Yes _____ No _____

Explain:

HUMAN FACTORS ENGINEERING QUESTIONNAIRE

TTS

Operator's Name: Nickerson (Last) Lawrence (First) E. (MI) Sgt. (Grade)

1. Previous night firing experience with night vision device(s) N/A

   a. Approximate number of hours N/A

   b. Explain circumstances (i.e., M60A1 (PI) night firing)

2. How do you feel about the TTS?

   X Very good

   _____ Above average

   _____ More than adequate

   _____ Could use some minor changes

   _____ Not very satisfactory

   _____ Very poor

   Explanations and comments:

3. How did you feel physically before using the TTS?

   _____ Extremely good

   _____ Very good in most respects

   _____ Good

   X Not very good

   _____ Poor

   _____ Extremely poor

   Explanations and comments:

4. Did you feel any discomforts or strains while using the TTS?

Yes _____ No __X__

Explanations/comments:

5. What features did you like best about the TTS?

Explanations/comments: That you could pick up something a lot faster with it.

6. What features did you dislike most about the TTS?

Explanations/comments: That you could not pick up things when it's foggy.

7. Would you recommend any changes to the TTS?

Yes __X__ No _____

If yes, explain: That they have some type of cover for the tank commander's place; and quiet the noise it makes.

8. Do you feel there are any unsafe features about the TTS?

a. Day Yes __X__ No _____

b. Night Yes _____ No __X__

c. Unusual weather conditions Yes _____ No _____

d. Explanations/comments: To see through tank commander position at daylight.

9. Do you feel the average operator will be able to operate with this system equally as efficient as with any other system?

Yes __X__ No _____

Explanations/comments: Once you learn it anyone could do it.

10. Do you feel that the average repairman will be able to troubleshoot and repair this system?

Yes X No _____

Why? It's not hard once you are school trained.

11. Do you feel that the average operator will be able to:

a. Operate this equipment? Yes X No _____

b. Service this equipment? Yes X No X

c. Remove and install this equipment? Yes X No _____

Explanations and comments: If the person has only knowledge.

12. Are gauges, dials, scales, and numbers adequate for clear vision during:

Day operation? Yes X No _____

Night operation? Yes X No _____

Unusual weather conditions (e.g., rain, snow, sleet, fog, etc)?

Yes _____ No X

Explanations and comments: Not during fog.

13. Must any attention be directed away from the target during adjustments of the TTS?

Yes _____ No X

Explain:

14. do you feel that instructions, labels, decals, etc., are adequate?

Yes X No _____

Explain:

15. Do you feel that warning instructions, labels, and decals are adequate?

Yes X No _____

Explain:

16. Do you feel that prolonged operations of the TTS would result in fatigue or eye strain?

Yes _____ No X

Explain:

17. Did you feel any fatigue or eye strain while operating the TTS?

Yes _____ No X

Explain:

18. Did you experience any after-effects from operating the TTS, i.e., headaches, vision, fatigue, or strains?

Yes _____ No X

Explain:

HUMAN FACTORS ENGINEERING QUESTIONNAIRE

TTS

Operator's Name: Behling (Last) Richard (First) A. (MI) E-3 (Grade)

1. Previous night firing experience with night vision device(s) No

   a. Approximate number of hours 0

   b. Explain circumstances (i.e., M60A1 (PI) night firing)

2. How do you feel about the TTS?

   X Very good

   _____ Above average

   _____ More than adequate

   X Could use some minor changes

   _____ Not very satisfactory

   _____ Very poor

   Explanations and comments: Can't manually traverse without tearing your knuckles off because of shield on retical knob.

3. How did you feel physically before using the TTS?

   _____ Extremely good

   _____ Very good in most respects

   X Good

   _____ Not very good

   _____ Poor

   _____ Extremely poor

   Explanations and comments:

4. Did you feel any discomforts or strains while using the TTS?

Yes _____ No __X__

Explanations/comments:

5. What feature did you like best about the TTS?

Explanations/comments: Wide traverse switch is a good thing.

6. What features did you dislike most about the TTS?

Explanations/comments: Having to refocus after switching from commander to gunner; noise of motor; wide/narrow needs better location; manual traverse clearance.

7. Would you recommend any changes to the TTS?

Yes __X__ No _____

If yes, explain: Made quieter; wide/narrow switch location; manual traverse handle clearance.

8. Do you feel there are any unsafe features about the TTS?

a. Day Yes _____ No __X__

b. Night Yes _____ No __X__

c. Unusual weather conditions Yes _____ No __X__

d. Explanations/comments: Manual traverse handle clearance.

9. Do you feel the average operator will be able to operate with this system equally as efficient as with any other system?

Yes __X__ No _____

Explanations/comments:

10. Do you feel that the average repairman will be able to troubleshoot and repair this system?

Yes _____ No _____

Why? _____

11. Do you feel that the average operator will be able to:

a. Operate this equipment? Yes _____ No _____

b. Service this equipment? Yes _____ No _____

c. Remove and install this equipment? Yes _____ No _____

Explanations and comments:

12. Are gauges, dials, scales, and numbers adequate for clear vision during:

Day operation? Yes __X__ No _____

Night operation? Yes __X__ No _____

Unusual weather conditions (e.g., rain, snow, sleet, fog, etc)?

Yes __X__ No _____

Explanations and comments:

13. Must any attention be directed away from the target during adjustments of the TTS?

Yes __X__ No _____

Explain:

14. Do you feel that instructions, labels, decals, etc., are adequate?

Yes __X__ No _____

Explain:

15. Do you feel that warning instructions, labels, and decals are adequate?

Yes __X__ No _____

Explain:

16. Do you feel that prolonged operations of the TTS would result in fatigue or eye strain?

Yes __X__ No _____

Explain: Daylight channel causes fatigue after 1/2 hour.

17. Did you feel any fatigue or eye strain while operating the TTS?

Yes __X__ No _____

Explain: After prolonged use of daylight.

18. Did you experience any after-effects from operating the TTS, i.e., headaches, vision, fatigue, or strains?

Yes __X__ No _____

Explain: Headache from prolonged daylight.

HUMAN FACTORS ENGINEERING QUESTIONNAIRE

TTS

Operator's Name: Behling (Last) Richard (First) A. (MI) E-3 (Grade)

1. Previous night firing experience with night vision device(s) None

   a. Approximate number of hours 0

   b. Explain circumstances (i.e., M60A1 (PI) night firing)

2. How do you feel about the TTS?

   ____ Very good

   ____ Above average

   ____ More than adequate

   X Could use some minor changes

   ____ Not very satisfactory

   ____ Very poor

   Explanations and comments: Retical adjustment knob too close to manual traverse handle.

3. How did you feel physically before using the TTS?

   ____ Extremely good

   ____ Very good in most respects

   X Good

   ____ Not very good

   ____ Poor

   ____ Extremely poor

   Explanations and comments:

4. Did you feel any discomforts or strains while using the TTS?

Yes X No _____

Explanations/comments: Motor is too loud.

5. What features did you like best about the TTS?

Explanations/comments: Capability to see through smoke and light fog.

6. What features did you dislike most about the TTS?

Explanations/comments: Inability to traverse manually without tearing your knuckles off.

7. Would recommend any changes to the TTS?

Yes X No _____

If yes, explain: See No. 2.

8. Do you feel there are any unsafe features about the TTS?

a. Day Yes _____ No X

b. Night Yes _____ No X

c. Unusual weather conditions Yes _____ No X

d. Explanations/comments: See No. 6.

9. Do you feel the average operator will be able to operate with this system equally as efficient as with any ohter system?

Yes X No _____

Explanations/comments:

10. Do you feel that the average repairman will be able to troubleshoot and repair this system?

Yes _____ No X

Why? He will have to be trained in electronics.

11. Do you feel that the average operator will be able to:

a. Operate this equipment? Yes X No _____

b. Service this equipment? Yes X No _____

c. Remove and install this equipment? Yes X No _____

Explanations and comments:

12. Are gauges, dials, scales, and numbers adequate for clear vision during:

Day operation? Yes X No _____

Night operation? Yes X No _____

Unusual weather conditions (e.g., rain, snow, sleet, fog, etc)?

Yes X No _____

Explanations and comments:

13. Must any attention be directed away from the target during adjustments of the TTS?

Yes _____ No X

Explain:

14. Do you feel that instructions, labels, decals, etc., are adequate?

Yes X No _____

Explain:

15. Do you feel that warning instructions, labels, and decals are adequate?

Yes _____ No X

Explain: See No. 6.

16. Do you feel that prolonged operations of the TTS would result in fatigue or eye strain?

Yes _____ No X

Explain:

17. Did you feel any fatigue or eye strain while operating the TTS?

Yes _____ No X

Explain:

18. Did you experience any after-effects from operating the TTS, i.e., headaches, vision, fatigue, or strains?

Yes X No _____

Explain: Too much noise from motor.

HUMAN FACTORS ENGINEERING QUESTIONNAIRE

TTS

Operator's Name: Arnold (Last) Dustin (First) J. (MI) E-4 (Grade)

1. Previous night firing experience with night vision device(s) No

   a. Approximate number of hours 0

   b. Explain circumstances (i.e., M60A1 (PI) night firing)

2. How do you feel about the TTS?

   X Very good

   _____ Above average

   _____ More than adequate

   _____ Not very satisfactory

   _____ Very poor

   Explanations and comments: It seems to be the best thing I've seen to be used at night. The best thing is, it is just as good in daylight also.

3. How did you feel physically before using the TTS?

   _____ Extremely good

   _____ Very good in most respects

   X Good

   _____ Not very good

   _____ Poor

   _____ Extremely poor

   Explanations and comments:

4. Did you feel any discomforts or strains while using the TTS?

Yes __X__ No _____

Explanations/comments: The manual traverse handle is too close to the sight. You constantly hit you hand while traversing. The sight is hard to keep focused. I have to readjust the focus (Daylight) about every ten minutes.

5. What features did you like best about the TTS?

Explanations/comments: I like the large viewer where you can see without sticking your eye to an eyepiece. I like the focus knob instead of a ring. I like the choice of fields of view.

6. What features did you dislike most about the TTS?

Explanations/comments: The noise the compressor makes. Having to reach over the Ballistic Drive to switch fields of view. Contrast and bright knobs are easily bumped or brushed out of focus. Gunner has no range finder readout, the gunner is helpless without TC.

7. Would you recommend any changes to the TTS?

Yes __X__ No _____

If yes, explain: Silence the compressor, change the manual traverse handle clearance, move the field of view handle, place a protective cover over the gunner's and TC's contrast and bright knobs. Give the gunner a range finder readout.

8. Do you feel there are any unsafe features about the TTS?

a. Day Yes __X__ No _____

b. Night Yes __X__ No _____

c. Unusual weather conditions Yes _____ No __X__

d. Explanations/comments: Manual traverse handle needs to have more clearance. Need a rubber pad on TC's viewer to protect TC from head injury during cross country maneuvers.

9. Do you feel the average operator will be able to operate with this system equally as efficient as with any other system?

Yes __X__ No _____

Explanations/comments: With proper training a soldier should have no problem using or maintaining the TTS sight. It is no more difficult than theXM50.

10. Do you feel that the average repairman will be able to troubleshoot and repair this system?

Yes __X__ No _____

Why? With proper training

11. Do you feel that the average operator will be able to:

a. Operate this equipment? Yes _____ No _____

b. Service this equipment? Yes _____ No _____

c. Remove and install this equipment? Yes _____ No _____

Explanations and comments

12. Are gauges, dials, scales, and numbers adequate for clear vision during:

Day operation? Yes _____ No _____

Night operation? Yes _____ No _____

Unusual weather conditions (e.g., rain, snow, sleet, fog, etc.)?

Yes __X__ No _____

Explanations and comments: The TTS night sight knobs are hard to read at night the dome light does not illuminate that area.

13. Must any attention be directed away from the target during adjustments of the TTS?

Yes _____ No __X__

Explain: Field of vision can be found but is in a hard place to reach.

14. Do you feel that instructions, labels, decals, etc., are adequate?

Yes X No _____

Explain:

15. Do you feel that warning instructions, labels, and decals are adequate?

Yes X No _____

Explain:

16. Do you feel that prolonged operations of the TTS would result in fatigue or eye strain?

Yes X No _____

Explain: On daylight sight eye fatigue is very great. Night channel I have no problem.

17. Did you feel any fatigue or eye strain while operating the TTS?

Yes X No _____

Explain: On daylight sight after 10 or 15 minutes of continuous observation vision gets blurry.

18. Did you experience any after-effects from operating the TTS, i.e., headaches, vision, fatigue, or strains?

Yes _____ No X

Explain:

HUMAN FACTORS ENGINEERING QUESTIONNAIRE

TTS

Operator's Name: Arnold (Last) Dustin (First) J. (MI) E-4 (Grade)

1. Previous night firing experience with night vision device(s) Yes

   a. Approximate number of hours 50

   b. Explain circumstances (i.e, M60A1 (PI) night firing)

   M60A2 night fire

2. How do you feel about the TTS?

   X Very good

   _____ Above average

   _____ More than adequate

   _____ Could use some minor changes

   _____ Not very satisfactory

   _____ Very poor

   Explanations and comments:

3. How did you feel physically before using the TTS?

   _____ Extremely good

   X Very good in most respects

   _____ Good

   _____ Not very good

   _____ Poor

   _____ Extremely poor

   Explanations and comments:

4. Did you feel any discomforts or strains while using the TTS?

Yes __X__ No _____

Explanations/comments: Manual traverse handle to close to sight.

5. What features did you like best about the TTS?

Explanations/comments: Contrast and bright knobs easily accessible.

6. What features did you dislike most about the TTS?

Explanations/comments: Contrast, bright and reticle bright knobs move too freely. Accidental turning puts you out of focus.

7. Would you recommend any changes to the TTS?

Yes __X__ No _____

If yes, explain: Make knobs so they will lock in position similar to boresight knobs.

8. Do you feel there are any unsafe features about the TTS?

a. Day Yes _____ No __X__

b. Night Yes _____ No __X__

c. Unusual weather conditions Yes _____ No __X__

d. Explanations/comments:

9. Do you feel the average operator will be able to operate with this system equally as efficient as with any other system?

Yes __X__ No _____

Explanations/comments:

10. Do you feel that the average repairman will be able to troubleshoot and repair this system?

Yes __X__ No _____

Why? _____

11. Do you feel that the average operator will be able to:

a. Operate this equipment? Yes __X__ No _____

b. Service this equipment? Yes __X__ No _____

c. Remove and install this equipment? Yes __X__ No _____

Explanations and comments:

12. Are gauges, dials, scales, and numbers adequate for clear vision during:

Day operation? Yes __X__ No _____

Night operation? Yes _____ No __X__

Unusual weather conditions (e.g., rain, snow, sleet, fog, etc)?

Yes __X__ No _____

Explanations and comments: TTS night sight boresight knobs are hard to see at night.

13. Must any attention be directed away from the target during adjustments of the TTS?

Yes _____ No __X__

Explain:

14. Do you feel that instructions, labels, decals, etc., are adequate?

Yes __X__ No _____

Explain:

15. Do you feel that warning instructions, labels, and decals are adequate?

Yes X No _____

Explain:

16. Do you feel that prolonged operations of the TTS would result in fatigue or eye strain?

Yes _____ No X

Explain:

17. Do you feel any fatigue or eye strain while operating the TTS?

Yes _____ No X

Explain:

18. Did you experience any after-effects from operating the TTS, i.e., headaches, vision, fatigue, or strains?

Yes _____ No X

Explain:

HUMAN FACTORS ENGINEERING QUESTIONNAIRE

TTS

Operator's Name: Stone (Last) Manuel (First) K. (MI) SP/4 (Grade)

1. Previous night firing experience with night vision device(s) Yes M32IR

   a. Approximate number of hours 15 hrs.

   b. Explain circumstances (i.e., M60A1 (PI) night firing)

   Night fight test.

2. How do you feel about the TTS?

   ___X___ Very good

   _____ Above average

   _____ More than adequate

   _____ Could use some minor changes

   _____ Not very satisfactory

   _____ Very poor

   Explanations and comments: It enables you to identify targets easier. It's more accurate than the standard sight.

3. How did you feel physically before using the TTS?

   _____ Extremely good

   _____ Very good in most respects

   ___X___ Good

   _____ Not very good

   _____ Poor

   _____ Extremely poor

   Explanations and comments:

4. Did you feel any discomforts or strains while using the TTS?

Yes _____ No __X__

Explanations/comments:

5. What features did you like best about the TTS?

Explanations/comments: You don't have to have your eye up against the lens.

6. What features did you dislike most about the TTS?

Explanations/comments: The contrast and brightness knob can be turned too easily. Just by brushing across them they move. The noise is too loud. The turning manual handle is too close to the sight.

7. Would you recommend any changes to the TTS?

Yes __X__ No _____

If yes, explain: Put lock knobs on the contrast and brightness knobs. Move the manual traversing handle back away from sight more. Find a way to quiet the noise down some.

8. Do you feel there are any unsafe features about the TTS?

A. Day Yes __X__ No _____

b. Night Yes __X__ No _____

c. Unusual weather conditions Yes _____ No _____

d. Explanations/comments: The 32 sight needs more eye protection when firing. The traversing handle will bust your knobs when trying.

9. Do you feel the average operator will be able to operate with this system equally as efficient as with any other system?

Yes __X__ No _____

Explanations/comments: If he is properly trained.

10. Do you feel that the average repairman will be able to troubleshoot and repair this system?

Yes _____ No _____

Why? _____

11. Do you feel that the average operator will be able to:

a. Operate this equipment? Yes _____ No _____

b. Service this equipment? Yes _____ No _____

c. Remove and install this equipment? Yes _____ No _____

Explanations and comments:

12. Are gauges, dials, scales, and numbers adequate for clear vision during:

Day operation? Yes _____ No X

Night operation? Yes _____ No X

Unusual weather conditions (e.g., rain, snow, sleet, fog, etc)?

Yes _____ No _____

Explanations and comments: The boresight knobs on night sight is up in an awkward position.

13. Must any attention be directed away from the target during adjustments of the TTS?

Yes _____ No _____

Explain:

14. Do you feel that instructions, labels, decals, etc., are adequate?

Yes X No _____

Explain:

15. Do you feel that warning instructions, labels, and decals are adequate?

Yes __X__ No _____

Explain:

16. Do you feel that prolonged operations of the TTS would result in fatigue or eye strain?

Yes __X__ No _____

Explain: Strain on eyes are hard. After looking through night channel everything is green.

17. Did you feel any fatigue or eye strain while operating the TTS?

Yes _____ No _____

Explain:

18. Did you experience any after-effects from operating the TTS, i.e, headaches, vision, fatigue, or strains?

Yes _____ No _____

Explain:

HUMAN FACTORS ENGINEERING QUESTIONNAIRE

TTS

Operator's Name: Stone (Last) Manuel (First) K. (MI) SP/4 (Grade)

1. Previous night firing experience with night vision device(s) Yes

   a. approximate number of hours 50 hrs.

   b. Explain circumstances (i.e., M60A1 (PI) night firing)

   Night fight test.

2. How do you feel about the TTS?

   X Very good

   _____ Above average

   _____ More than adequate

   _____ Could use some minor changes

   _____ Not very satisfactory

   _____ Very poor

   Explanations and comments: I like the wide field of view and black and white hot.

3. How did you feel physically before using the TTS?

   X Extremely good

   _____ Very good in most respects

   _____ Good

   _____ Not very good

   _____ Poor

   _____ Extremely poor

   Explanations and comments: I was in top plysical condition.

4. Did you feel any discomforts or strains while using the TTS?

Yes __X__ No _____

Explanations/comments: After long periods of looking through the sight everything looked green.

5. What features did you like best about the TTS?

Explanations/comments:

White hot, black hot
Wide field of view

6. What features did you dislike most about the TTS?

Explanations/comments: Manual traversing handle is too close.

7. Would you recommend any changes to the TTS?

Yes __X__ No _____

If yes, explain: Locking knobs on the focus and adjusting knobs.

8. Do you feel there are any unsafe features about the TTS?

a. Day Yes _____ No __X__

b. Night Yes _____ No _____

c. Unusual weather conditions Yes _____ No _____

d. Explanations/comments

9. Do you feel the average operator will be able to operate with this system equally as efficient as with any other system?

Yes __X__ No _____

Explanations/comments: With proper training.

10. Do you feel that the average repairman will be able to troubleshoot and repair this system?

Yes X No _____

Why? _____

11. Do you feel that the average operator will be able to:

a. Operate this equipment? Yes X No _____

b. Service this equipment? Yes X No _____

c. Remove and install this equipment? Yes X No _____

Explanations and comments: With proper training.

12. Are gauges, dials, scales, and numbers adequate for clear vision during:

Day operation? Yes _____ No X

Night operation? Yes _____ No X

Unusual weather conditions (e.g., rain, snow, sleet, fog, etc)?

Yes _____ No X

Explanations and comments: You would have to look from your sight to find some adjustments.

13. Must any attention be directed away from the target during adjustments of the TTS?

Yes X No _____

Explain: When boresighting the adjustment knobs are in a hard to get to place.

14. Do you feel that instructions, labels, decals, etc., are adequate?

Yes _____ No X

Explain: Should be made visible.

15. Do you feel that warning instructions, labels, and decals are adequate?

Yes _____ No X

Explain: Should be more visible.

16. Do you feel that prolonged operations of the TTS would result in fatigue or eye strain?

Yes X No _____

Explain: Eyes, things will look green after the use of sight.

17. Did you feel any fatigue or eye strain while operating the TTS?

Yes X No _____

Explain: Same as 16.

18. Did you experience any after-effects from operating the TTS, i.e., headaches, vision, fatigue, or strains?

Yes X No _____

Explain: Same as 16 and 17.

HUMAN FACTORS ENGINEERING QUESTIONNAIRE

TTS

Operator's Name: Lanier (Last) James (First) E. (MI) E6 (Grade)

1. Previous night firing experience with night vision device(s) Yes M32IR-M36E1

   a. Approximate number of hours 200 hrs. M36E1

   b. Explain circumstances (i.e., M60A1 (PI) night firing)

   M60A1, M36E1, night fight test, PH 2 & 3.

2. How do you feel about the TTS?

   ___ Very good
   ___ Above average
   ___ More than adequate
   X Could use some minor changes
   ___ Not very satisfactory
   ___ Very poor

   Explanations and comments: The sight is very good because it has the capability to distinguish targets in pitch by heat alone. But the sight needs to have some of the controls moved to the side.

3. How did you feel physically before using the TTS?

   ___ Extremely good
   X Very good in most respects
   ___ Good
   ___ Not very good
   ___ Poor
   ___ Extremely poor

   Explanations and comments:

4. Did you feel any discomforts or strains while using the TTS?

Yes X No _____

Explanations/comments: While I was looking through the night channel I felt my eyes being strained and had to look harder to see anything.

5. What features did you like best about the TTS?

Explanations/comments: I liked the black hot and white hot. Also the fact that you didn't have to put your face up to the sight to see the target.

6. What features did you dislike most about the TTS?

Explanations/comments: I disliked the noise or the field of view. It could be moved to the side.

7. Would you recommend any changes to the TTS?

Yes X No _____

If yes, explain: Move the ratical knob to the side so you could traverse the turret. The TTS night channel needs to have a rubber cover around it so the gunner won't hit his head.

8. Do you feel there are any unsafe features about the TTS?

a. Day Yes _____ No X

b. Night Yes X No _____

c. Unusual weather conditions Yes _____ No X

d. Explanations/comments: The gunner and TC view scope needs the rubber guard around the viewer.

9. Do you feel the average operator will be able to operate with this system equally as efficient as with any other system?

Yes X No _____

Explanations/comments: All you have to do is turn it on after the right training.

10. Do you feel that the average repairman will be able to troubleshoot and repair this system?

Yes _____ No __X__

Why? Because the man needs to be a computer repairman.

11. Do you feel that the average operator will be able to:

a. Operate this equipment? Yes _____ No _____

b. Service this equipment? Yes _____ No _____

c. Remove and install this equipment? Yes _____ No _____

Explanations and comments:

12. Are gauges, dials, scales, and numbers adequate for clear vision during:

Day operation? Yes __X__ No _____

Night operation? Yes __X__ No _____

Unusual weather conditions (e.g., rain, snow, sleet, fog, etc)?

Yes _____ No _____

Explanations and comments:

13. Must any attention be directed away from the target during adjustments of the TTS?

Yes _____ No __X__

Explain:

14. Do you feel that instructions, labels, decals, etc., are adequate?

Yes __X__ No _____

Explain:

15. Do you feel that warning instructions, labels, and decals are adequate?

Yes _____ No __X__

Explain:

16. Do you feel that prolonged operations of the TTS would result in fatigue or eye strain?

Yes __X__ No _____

Explain: Night channel.

17. Did you feel any fatigue or eye strain while operating the TTS?

Yes __X__ No _____

Explain: After looking through the night channel for about 1/2-hour I felt strain and found it difficult to make out targets.

18. Did you experience any after-effects from operating the TTS, i.e., headaches, vision, fatigue, or strains?

Yes _____ No _____

Explain:

HUMAN FACTORS ENGINEERING QUESTIONNAIRE

TTS

Operator's Name: Lanier (Last) James (First) E. (MI) E6 (Grade)

1. Previous night firing experience with night vision device(s) Night fight test, PH II and III

   a. Approximate number of hours 100

   b. Explain circumstances (i.e., M60A1 (PI) night firing)

   M60A1 AOS, 36E1

2. How do you feel about the TTS?

   X Very good

   _____ Above average

   _____ More than adequate

   _____ Could use some minor changes

   _____ Not very satisfactory

   _____ Very poor

   Explanations and comments: The TTS has 100% better capability of distinguishing targets at a greater range.

3. How did you feel physically before using the TTS?

   _____ Extremely good

   _____ Very good in most respects

   X Good

   _____ Not very good

   _____ Poor

   _____ Extremely poor

   Explanations and comments:

4. Did you feel any discomforts or strains while using the TTS?

Yes __X__ No _____

Explanations/comments: After using the system for a prolonged time, I noticed that I had trouble focusing on the target.

5. What features did you like best about the TTS?

Explanations/comments: I liked the field of view the best. Also the polarity change.

6. What features did you dislike most about the TTS?

Explanations/comments: I found it difficult to adjust the retocal for the day and night channel. Also the infinity sight.

7. Would you recommend any changes to the TTS?

Yes __X__ No _____

If yes, explain: Move all retocal knobs to a central location for easy adjustment.

8. Do you feel there are any unsafe features about the TTS?

a. Day Yes _____ No __X__

b. Night Yes _____ No __X__

c. Unusual weather conditions Yes _____ No __X__

d. Explanations/comments:

9. Do you feel the average operator will be able to operate with this system equally as efficient as with any other system?

Yes __X__ No _____

Explanations/comments: If he is trained right.

10. Do you feel that the average repairman will be able to troubleshoot and repair this system?

Yes __X__ No _____ Yes and No.

Why? __Because repairmen can troubleshoot ok, but repair is at least a 34G.

11. Do you feel that the average operator will be able to:

a. Operate this equipment? Yes __X__ No _____

b. Service this equipment? Yes _____ No __X__

c. Remove and install this equipment? Yes __X__ No _____

Explanations and comments:

12. Are gauges, dials, scales, and numbers adequate for clear vision during:

Day operation? Yes _____ No __X__

Night operation? Yes _____ No __X__

Unusual weather conditions (e.g, rain, snow, sleet, fog, etc)?

Yes _____ No __X__

Explanations and comments: All retocal knobs are difficult to see because of location.

13. Must any ateention be directed away from the target during adjustments of the TTS?

Yes _____ No __X__

Explain:

14. Do you feel that instructions, labels, decals, etc., are adequate?

Yes __X__ No _____

Explain:

15. Do you feel that warning instructions, labels, and decals are adequate?

Yes X No _____

Explain:

16. Do you feel that prolonged operations of the TTS would result in fatigue or eye strain?

Yes X No _____

Explain:

17. Did you feel any fatigue or eye strain while operating the TTS?

Yes _____ No _____

Explain: Refer to question 4.

18. Did you experience any after-effects from operating the TTS, i.e., headaches, vision, fatigue, or strains?

Yes _____ No X

Explain:

HUMAN FACTORS ENGINEERING QUESTIONNAIRE

TTS

Operator's Name: Williams (Last) John (First) K. (MI) E5 (Grade)

1. Previous night firing experience with night vision device(s) Yes

   a. Approximate number of hours 20

   b. Explain circumstances (i.e., M60A1 (PI) night firing)

   Yes M32IR - M60A1 Qualification Course.

2. How do you feel about the TTS?

   X Very good

   _____ Above average

   _____ More than adequate

   _____ Could use some minor changes

   _____ Not very satisfactory

   _____ Very poor

   Explanations and comments: You can see better and pick up objects better than thru the old IR system and it's more accurate you can lay on target easier.

3. How did you feel physically before using the TTS?

   X Extremely good

   _____ Very good in most respects

   _____ Good

   _____ Not very good

   _____ Poor

   _____ Extremely poor

   Explanations and comments:

4. Did you feel any discomforts or strains while using the TTS?

Yes __X__ No _____

Explanations/comments: Using daylight sight my eyes became strained and blurred after a minute or more during the target acquisition test.

5. What features did you like best about the TTS?

Explanations/comments: I like the night sight viewing display for both the gunner and TC. The filter knob is rather good instead of having to place different lenses on the eyepiece.

6. What features did you dislike most about the TTS?

Explanations/comments: The lever for the NFV and WFV needs to be in a more accessible place. The contrast and brightness knob needs some kind of cover put over them. Needs better headrest especially on the day sight.

7. Would you recommend any changes to the TTS?

Yes __X__ No _____

If yes, explain: Movement of the NFV/WFV lever movement or covers for contrast and brightness knobs -- different headrest.

8. Do you feel there are any unsafe features about the TTS?

a. Day Yes _____ No __X__

b. Night Yes __X__ No _____

c. Unusual weather conditions Yes _____ No __X__

d. Explanations/comments: Headrest or cushion on commander viewer.

9. Do you feel the average operator will be able to operate with this system equally as efficient as with any other system?

Yes __X__ No _____

Explanations/comments:

10. Do you feel that the average repairman will be able to troubleshoot and repair this system?

Yes _____ No _____

Why? _____

11. Do you feel that the average operator will be able to:

a. Operate this equipment? Yes _____ No _____

b. Service this equipment? Yes _____ No _____

c. Remove and install this equipment? Yes _____ No _____

Explanations and comments:

12. Are gauges, dials, scales, and numbers adequate for clear vision during:

Day operation? Yes __X__ No _____

Night operation? Yes __X__ No _____

Unusual weather conditions (e.g., rain, snow, sleet, fog, etc)?

Yes __X__ No _____

Explanations and comments:

13. Must any attention be directed away from the target during adjustments of the TTS?

Yes _____ No __X__

Explain:

14. Do you feel that instructions, labels, decals, etc., are adequate?

Yes __X__ No _____

Explain:

15. Do you feel that warning instructions, labels, and decals are adequate?

Yes X No _____

Explain:

16. Do you feel that prolonged operations of the TTS would result in fatigue or eye strain?

Yes X No _____

Explain: Daylight sight strains my eyes after a period of time.

17. Did you feel any fatigue or eye strain while operating the TTS?

Yes X No _____

Explain: Eye strain after a short time of using the daylight sight.

18. Did you experience any after-effects from operating the TTS, i.e., headaches, vision, fatigue, or strains?

Yes X No _____

Explain: Eye strains.

HUMAN FACTORS ENGINEERING QUESTIONNAIRE

TTS

Operator's Name: Williams (Last) John (First) K. (MI) E5 (Grade)

1. Previous night firing experience with night vision device(s) IR

   a. Approximate number of hours 20

   b. Explain circumstances (i.e., M60A1 (PI) night firing)

   M60A1 night firing.

2. How do you feel about the TTS?

   X Very good

   _____ Above average

   _____ More than adequate

   X Could use some minor changes

   _____ Not very satisfactory

   _____ Very poor

   Explanations and comments:

3. How did you feel physically before using the TTS?

   X Extremely good

   _____ Very good in most respects

   _____ Good

   _____ Not very good

   _____ Poor

   _____ Extremely poor

   Explanations and comments:

4. Did you feel any discomforts or strains while using the TTS?

Yes __X__ No _____

Explanations/comments: TTS daylight strained my eyes after a short period of time.

5. What features did you like best about the TTS?

Explanations/comments: The night channel viewer and commander's display.

6. What features did you dislike most about the TTS? No headrest on commander's display, position of field of view lever, position of contrast and brightness knobs, positions of boresight knobs, both day and night. Manual traverse too close to sight for clearance of the hand.

7. Would you recommend any changes to the TTS?

Yes __X__ No _____

If yes, explain: See number 6.

8. Do you feel there are any unsafe features about the TTS?

a. Day Yes _____ No __X__

b. Night Yes _____ No __X__

c. Unusual weather conditions Yes _____ No __X__

d. Explanations/comments:

9. Do you feel the average operator will be able to operate with this system equally as efficient as with any other system?

Yes __X__ No _____

Explanations/comments:

10. Do you feel that the average repairman will be able to troubleshoot and repair this system?

Yes _____ No X

Why? Too complicated.

11. Do you feel that the average operator will be able to:

a. Operate this equipment? Yes X No _____

b. Service this equipment? Yes _____ No X

c. Remove and install this equipment? Yes X No _____

Explanations and comments:

12. Are gauges, dials, scales, and numbers adequate for clear vision during:

Day operation? Yes X No _____

Night operation? Yes X No _____

Unusual weather conditions (e.g., rain, snow, sleet, fog, etc)?

Yes X No _____

Explanations and comments:

13. Must any attention be directed away from the target during adjustments of the TTS?

Yes _____ No X

Explain:

14. Do you feel that instructions, labels, decals, etc., are adequate?

Yes X No _____

Explain:

15. Do you feel that warning in structions, labels, and decals are adequate?

Yes __X__ No _____

Explain:

16. Do you feel that prolonged operations of the TTS would result in fatigue or eye strain?

Yes __X__ No _____

Explain: Just the daylight sight.

17. Did you feel any fatigue or eye strain while operating the TTS?

Yes __X__ No _____

Explain: Through the daylight.

18. Did you experience any after-effects from operating the TTS, i.e., headaches, vision, fatigue, or strains?

Explain: Eyestrain through the daylight.

HUMAN FACTORS ENGINEERING QUESTIONNAIRE

TTS

Operator's Name: Whetsel (Last) Carl (First) D. (MI) E-3 (Grade)

1. Previous night firing experience with night vision device(s) Yes M32-IR

   a. Approximate number of hours 2

   b. Explain circumstances (i.e., M60A1 (PI) night firing)

   Practice - tank gunnery.

2. How do you feel about the TTS?

   X Very good

   _____ Above average

   _____ More than adequate

   _____ Could use some minor changes

   _____ Not very satisfactory

   _____ Very poor

   Explanations and comments: Eliminates searchlight; extremely good view through dust, etc.; enables you to identify target quickly.

3. How did you feel physically before using the TTS?

   _____ Extremely good

   X Very good in most respects

   _____ Good

   _____ Not very good

   _____ Poor

   _____ Extremely poor

   Explanations and comments:

4. Did you feel any discomforts or strains while using the TTS?

Yes _____ No __X__

Explanations/comments:

5. What features did you like best about the TTS?

Explanations/comments: I'm a loader -- didn't really use much.

6. What features did you dislike most about the TTS?

Explanations/comments: I didn't like the noise it makes. Your fingers hit the sight when traversing manually.

7. Would you recommend any changes to the TTS?

Yes __X__ No _____

If yes, explain: Muffle the noise the pistons make in the TTS. Shave the lower right corner of the TTS sight, to add more clearance for traversing manually.

8. Do you feel there are any unsafe features about the TTS?

a. Day Yes _____ No __X__

b. Night Yes _____ No __X__

c. Unusual weather conditions Yes _____ No __X__

d. Explanations/comments:

9. Do you feel the average operator will be able to operate with this system equally as efficient as with any other system?

Yes __X__ No _____

Explanations/comments:

10. Do you feel that the average repairman will be able to troubleshoot and repair this system?

Yes _____ No _____

Why? _____

11. Do you feel that the average operator will be able to:

a. Operate this equipment? Yes _____ No _____

b. Service this equipment? Yes _____ No _____

c. Remove and install this equipment? Yes _____ No _____

Explanations and comments:

12. Are gauges, dials, scales, and numbers adequate for clear vision during:

Day operation? Yes X No _____

Night operation? Yes X No _____

Unusual weather conditions (e.g., rain, snow, sleet, fog, etc)?

Yes X No _____

Explanations and comments:

13. Must any attention be directed away from the target during adjustments of the TTS?

Yes _____ No X

Explain:

14. Do you feel that instructions, labels, decals, etc., are adequate?

Yes _____ No _____

Explain: N/A.

15. Do you feel that warning instructions, labels, and decals are adequate?

Yes _____ No _____

Explain: N/A.

16. Do you feel that prolonged operations of the TTS would result in fatigue or eye strain?

Yes _____ No X

Explain: Did't use it long enough.

17. Did you feel any fatigue or eye strain while operating the TTS?

Yes _____ No _____

Explain: N/A.

18. Did you experience any after-effects from operating the TTS, i.e., headaches, vision, fatigue, or strains?

Yes _____ No X

Explain:

HUMAN FACTORS ENGINEERING QUESTIONNAIRE

TTS

Operator's Name: Whetsel (Last) Carl (First) D. (MI) E-3 (Grade)

1. Previous night firing experience with night vision device(s) Yes

   a. Approximate number of hours 2

   b. Explain circumstances (i.e., M60A1 (PI) night firing)

2. How do you feel about the TTS?

   ____ Very good

   X Above average

   ____ More than adequate

   ____ Could use some minor changes

   ____ Not very satisfactory

   ____ Very poor

   Explanations and comments:

3. How did you feel physically before using the TTS?

   ____ Extremely good

   X Very good in most respects

   ____ Good

   ____ Not very good

   ____ Poor

   ____ Extremely poor

   Explanations and comments:

4. Did you feel any discomforts or strains while using the TTS?

Yes X No _____

Explanations/comments: Manual traversing handle smashes your fingers on the sight.

5. What features did you like best about the TTS?

Explanations/comments: Ability to see through smoke. You can see at night without a searchlight, you can observe without giving away your position.

6. What features did you dislike most about the TTS?

Explanations/comments: Smashing your fingers. The noise the cooling system makes. It it's raining your vision through the sight is poor.

7. Would you recommend any changes to the TTS?

Yes X No _____

If yes, explain: Taper corner of sight to allow clearance for manual traverse.

8. Do you feel there are any unsafe features about the TTS?

a. Day Yes _____ No X

b. Night Yes _____ No X

c. Unusual weather conditions Yes _____ No X

d. Explanations/comments:

9. Do you feel the average operator will be able to operate with this system equally as efficient as with any other systems?

Yes _____ No X

Explanations/comments: I've worked with some pretty ignorant people since I've been in the Army.

10. Do you feel that the average repairman will be able to troubleshoot and repair this system?

Yes _____ No __X__

Why? It's a little complex. A good repairman can, the average will get lost.

11. Do you feel that the average operator will be able to:

a. Operate this equipment? Yes __X__ No _____

b. Service this equipment? Yes __X__ No _____

c. Remove and install this equipment? Yes __X__ No _____

Explanations and comments:

12. Are gauges, dials, scales, and numbers adequate for clear vision during:

Day operation? Yes __X__ No _____

Night operation? Yes __X__ No _____

Unusual weather conditions (e.g., rain, snow, sleet, fog, etc)?

Yes __X__ No _____

Explanations and comments:

13. Must any attention be directed away from the target during adjustments of the TTS?

Yes _____ No __X__

Explain:

14. Do you feel that instructions, labels, decals, etc., are adequate?

Yes __X__ No _____

Explain:

15. Do you feel that warning instructions, labels, and decals are adequate?

Yes X No _____

Explain:

16. Do you feel that prolonged operations of the TTS would result in fatigue or eye strain?

Yes _____ No X

Explain:

17. Did you feel any fatigue or eye strain while operating the TTS?

Yes _____ No X

Explain:

18. Did you experience any after-effects from operating the TTS, i.e., headaches, vision, fatigue, or strains?

Yes _____ No X

Explain:

HUMAN FACTORS ENGINEERING QUESTIONNAIRE

TTS

Operator's Name: Wessner (Last) Todd (First) A. (MI) E-5 (Grade)

1. Previous night firing experience with night vision device(s) Yes M-32 IR

   a. Approximate number of hours 5

   b. Explain circumstances (i.e., M60A1 (PI) night firing)

   AIT and tank gunnery.

2. How do you feel about the TTS?

   ___X___ Very good

   _____ Above average

   _____ More than adequate

   _____ Could use some minor changes

   _____ Not very satisfactory

   _____ Very poor

   Explanations and comments: It is a faster means of identification and there is not a searchlight involved.

3. How did you feel physically before using the TTS?

   _____ Extremely good

   _____ Very good in most respects

   ___X___ Good

   _____ Not very good

   _____ Poor

   _____ Extremely poor

   Explanations and comments:

4. Did you feel any discomforts or strains while using the TTS?

Yes _____ No __X__

Explanations/comments: I never used the TTS sight myself.

5. What features did you like best about the TTS?

Explanations/comments: No direct contact.

6. What features did you dislike most about the TTS?

Explanations/comments: The noise.

7. Would you recommend any changes to the TTS?

Yes __X__ No _____

If yes, explain: Manual traverse handle is too close to sight.

8. Do you feel there are any unsafe features about the TTS?

a. Day Yes _____ No __X__

b. Night Yes _____ No __X__

c. Unusual weather conditions Yes _____ No _____

d. Explanations/comments:

9. Do you feel the average operator will be able to operate with this system equally as efficent as with any other system?

Yes __X__ No _____

Explanations/comments:

10. Do you feel that the average repairman will be able to troubleshoot and repair this system?

Yes _____ No _____

Why? _____

11. Do you feel that the average operator will be able to:

a. Operate this equipment? Yes _____ No _____

b. Service this equipment? Yes _____ No _____

c. Remove and install this equipment? Yes _____ No _____

Explanations and comments:

12. Are gauges, dials, scales, and numbers adequate for clear vision during:

Day operation? Yes __X__ No _____

Night operation? Yes __X__ No _____

Unusual weather conditions (e.g., rain, snow, sleet, fog, etc)?

Yes __X__ No _____

Explanations and comments:

13. Must any attention be directed away from the target during adjustments of the TTS?

Yes _____ No __X__

Explain:

14. Do you feel that instructions, labels, decals, etc., are adequate?

Yes __X__ No _____

Explain:

15. Do you feel that warning instructions, labels, and decals are adequate?

Yes X No _____

Explain:

16. Do you feel that prolonged operations of the TTS would result in fatigue or eye strain?

Yes _____ No X

Explain: Do direct contact with using the sight.

17. Did you feel any fatigue or eye strain while operating the TTS?

Yes _____ No X

Explain:

18. Did you experience any after-effects from operating the TTS, i.e., headaches, vision, fatigue, or strains?

Yes _____ No X

Explain: N/A.

HUMAN FACTORS ENGINEERING QUESTIONNAIRE

TTS

Operator's Name: Wessner (Last) Todd (First) A. (MI) E-5 (Grade)

1. Previous night firing experience with night vision device(s) Yes

   a. Approximate number of hours _____

   b. Explain circumstances (i.e, M60A1 (PI) night firing)

2. How do you feel about the TTS?

   X Very good

   _____ Above average

   _____ More than adequate

   _____ Could use some minor changes

   _____ Not very satisfactory

   _____ Very poor

   Explanations and comments:

3. How did you feel physically before using the TTS?

   _____ Extremely good

   X Very good in most respects

   _____ Good

   _____ Not very good

   _____ Poor

   _____ Extremely poor

   Explanations and comments:

4. Did you feel any discomforts or strains while using the TTS?

Yes _____ No X

Explanations/comments:

5. What features did you like best about the TTS?

Explanations/comments: Good visibility day or night.

6. What features did you dislike most about the TTS?

Explanations/comments: The noise.

7. Would you recommend any changes to the TTS?

Yes _____ No X

If yes, explain:

8. Do you feel there are any unsafe features about the TTS?

a. Day Yes _____ No X

b. Night Yes _____ No X

c. Unusual weather conditions Yes _____ No X

d. Explanations/comments:

9. Do you feel the average operator will be able to operate with this system equally as efficient as with any other system?

Yes X No _____

Explanations/comments:

10. Do you feel that the average repairman will be able to troubleshoot and repair this system?

Yes X No _____

Why? _____

11. Do you feel that the average operator will be able to:

a, Operate this equipment? Yes X No _____

b. Service this equipment? Yes X No _____

c. Remove and install this equipment? Yes X No _____

Explanations and comments:

12. Are gauges, dials, scales, and numbers adequate for clear vision during:

Day operation? Yes X No _____

Night operation? Yes X No _____

Unusual weather conditions (e.g., rain, snow, sleet, fog, etc)?

Yes X No _____

Explanations and comments:

13. Must any attention be directed away from the target during adjustments of the TTS?

Yes _____ No X

Explain:

14. Do you feel that instructions, labels, decals, etc., are adequate?

Yes X No _____

Explain:

15. Do you feel that warning instructions, labels, and decals are adequate?

Yes X No _____

Explain:

16. Do you feel that prolonged operations of the TTS would result in fatigue or eye strain?

Yes _____ No X

Explain:

17. Did you feel any fatigue or eye strain while operating the TTS?

Yes _____ No X

Explain:

18. Did you experience any after-effects from operating the TTS, i.e., headaches, vision, fatigue, or strains?

Yes _____ No X

Explain:

HUMAN FACTORS ENGINEERING QUESTIONNAIRE

TTS

Operator's Name: Symons (Last) Tim (First) H. (MI) E5 (Grade)

1. Previous night firing experience with night vision device(s) None

   a. Approximate number of hours 0

   b. Explain circumstances (i.e., M60A1 (PI) night firing)

2. How do you feel about the TTS?

   X Very good

   _____ Above average

   _____ More than adequate

   _____ Could use some minor changes

   _____ Not very satisfactory

   _____ Very poor

   Explanations and comments: I think TTS is very good because it is preparing you for the future. You will be one more step ahead of you contemporaries.

3. How did you feel physically before using the TTS?

   _____ Extremely good

   X Very good in most respects

   _____ Good

   _____ Not very good

   _____ Poor

   _____ Extremely poor

   Explanations and comments:

4. Did you feel any discomforts or strains while using the TTS?

Yes X No _____

Explanations/comments: After staring into the TTS for long periods, I would get headaches, probably because I was straining my eyes, looking for targets after dark.

5. What features did you like best about the TTS?

Explanations/comments: Everything on the machine is very handy. Biocular eyepiece is a good feature. You do not have to lean into the sight itself.

6. What features did you dislike most about the TTS?

Explanations/comments: Noise of the TTS. The wide field of view should be up front by the barrel so you don't have to reach up for the switch. Clearance of sight and manual traverse handle.

7. Would you recommend any changes to the TTS?

Yes X No _____

If yes, explain: Move the field of view switch to a more comfortable position. Eliminate noise and contour the sight so you have proper clearance to use the manual traverse handle.

8. Do you feel there are any unsafe features about the TTS?

a. Day Yes _____ No X

b. Night Yes _____ No X

c. Unusual weather conditions Yes _____ No X

d. Explanations/comments: Eye guard boot for range finder of gunner's eyepiece.

9. Do you feel the average operator will be able to operate with this system equally as efficient as with any other system?

Yes X No _____

Explanations/comments: If he is properly trained for the system.

AD-A051 650 CHRYSLER CORP CENTER LINE MI WARREN DEFENSE DIV F/G 17/5
CONTRACTOR PROTOTYPE QUALIFICATION TEST (PQT-C) M60A1(PI) TANK --ETC(U)
DEC 77 R PAVER DAAK30-76-C-0005

UNCLASSIFIED NL

3 OF 3
AD
A051 650

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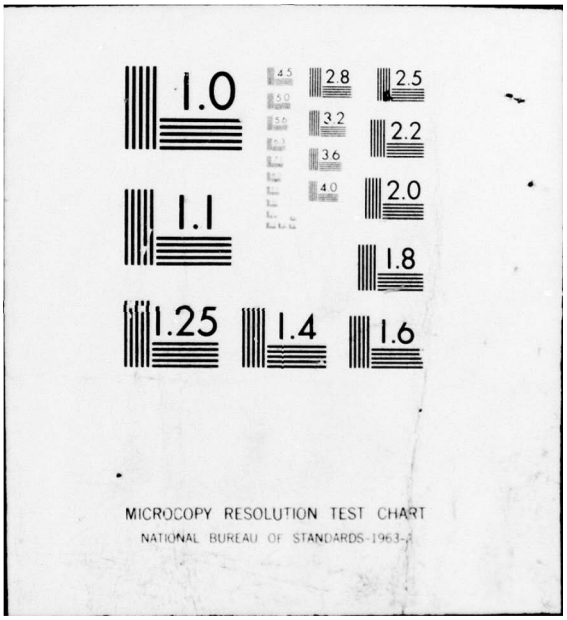
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1.1
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

10. Do you feel that the average repairman will be able to troubleshoot and repair this system?

Yes _____ No _____

Why? _____

11. Do you feel that the average operator will be able to:

a. Operate this equipment? Yes _____ No _____

b. Service this equipment? Yes _____ No _____

c. Remove and install this equipment? Yes _____ No _____

Explanations and comments:

12. Are gauges, dials, scales, and numbers adequate for clear vision during:

Day operation? Yes X No _____

Night operation? Yes _____ No X

Unusual weather conditions (e.g., rain, snow, sleet, fog, etc)?

Yes _____ No _____

Explanations and comments: Should be a service light on TTS for findings at night.

13. Must any attention be directed away from the target during adjustments of the TTS?

Yes _____ No _____

Explain: N/A.

14. Do you feel that instructions, labels, decals, etc., are adequate?

Yes X No _____

Explain:

15. Do you feel that warning instructions, labels, and decals are adequate?

Yes __X__ No _____

Explain:

16. Do you feel that prolonged operations of the TTS would result in fatigue or eye strain?

Yes __X__ No _____

Explain: After long periods of night channel observation results in eye strain and headaches.

17. Did you feel any fatigue or eye strain while operating the TTS?

Yes __X__ No _____

Explain: After long periods, approximately 12 hours.

18. Did you experience any after-effects from operating the TTS, i.e., headaches, vision, fatigue, or strains?

Yes __X__ No _____

Explain: After periods of night channel observation, outside of tank viewing light bloches would appear. Viewing objects would seem to be somewhat distorted. Clearing of eyes takes place about 5 minutes after clearing out of tank.

HUMAN FACTORS ENGINEERING QUESTIONNAIRE

TTS

Operator's Name: Black (Last) LaVerne (First) E. (MI) E-5 (Grade)

1. Previous night firing experience with night vision device(s) Yes

   a. Approximate number of hours 20-25 hrs.

   b. Explain circumstances (i.e., M60A1 (PI) night firing)

   M32IR gunnery qualification.

2. How do you feel about the TTS?

   X Very good

   _____ Above average

   _____ More than adequate

   _____ Could use some minor changes

   _____ Not very satisfactory

   _____ Very poor

   Explanations and comments:

3. How did you feel physically before using the TTS?

   X Extremely good

   _____ Very good in most respects

   _____ Good

   _____ Not very good

   _____ Poor

   _____ Extremely poor

   Explanations and comments:

4. Did you feel any discomforts or strains while using the TTS?

Yes __X__ No _____

Explanations/comments: Boresight knobs -- daylight channel hard to use while sighting.

5. What features did you like best about the TTS?

Explanations/comments: I like the ability to switch from wide to narrow field, biocular eyepiece is good.

6. What features did you dislike most about the TTS?

Explanations/comments: Noise, boresight knobs daylight channel. TC's lightpipe need padding.

7. Would you recommend any changes to the TTS?

Yes __X__ No _____

If yes, explain: Boresight knobs daylight channel -- relocate manual traverse -- too close to sight.

8. Do you feel there are any unsafe features about the TTS?

a. Day Yes __X__ No _____

b. Night Yes __X__ No _____

c. Unusual weather conditions Yes _____ No _____

d. Explanations/comments: TC's lightpipe needs eyepiece padding manual traverse — relocate.

9. Do you feel the average operator will be able to operate with this system equally as efficient as with any other system?

Yes __X__ No _____

Explanations/comments: Very easy to operate.

10. Do you feel that the average repairman will be able to troubleshoot and repair this system?

Yes _____ No _____

Why? _____

11. Do you feel that the average operator will be able to:

a. Operate this equipment? Yes _____ No _____

b. Service this equipment? Yes _____ No _____

c. Remove and install this equipment? Yes _____ No _____

Explanations and comments:

12. Are gauges, dials, scales, and numbers adequate for clear vision during:

Day operation? Yes __X__ No _____

Night operation? Yes __X__ No _____

Unusual weather conditions (e.g., rain, snow, sleet, fog, etc)?

Yes __X__ No _____

Explanations and comments:

13. Must any attention be directed away from the target during adjustments of the TTS?

Yes _____ No __X__

Explain:

14. Do you feel that instructions, labels, decals, etc., are adequate?

Yes __X__ No _____

Explain:

15. Do you feel that warning instructions, labels, and decals are adequate?

Yes X No _____

Explain:

16. Do you feel that prolonged operations of the TTS would result in fatigue or eye strain?

Yes _____ No X

Explain:

17. Did you feel any fatigue or eye strain while operating the TTS?

Yes _____ No X

Explain:

18. Did you experience any after-effects from operating the TTS, i.e., headaches, vision, fatigue, or strains?

Yes _____ No X

Explain:

HUMAN FACTORS ENGINEERING QUESTIONNAIRE

TTS

Operator's Name: Burditt (Last) Martin (First) A. (MI) E-4 (Grade)

1. Previous night firing experience with night vision device(s) None

   a. Approximate number of hours _____

   b. Explain circumstances (i.e., M60A1 (PI) night firing)

2. How do you feel about the TTS?

   X Very good

   _____ Above average

   _____ More than adequate

   _____ Could use some minor changes

   _____ Not very satisfactory

   _____ Very poor

   Explanations and comments:

3. How did you feel physically before using the TTS?

   X Extremely good

   _____ Very good in most respects

   _____ Good

   _____ Not very good

   _____ Poor

   _____ Extremely poor

   Explanations and comments:

4. Did you feel any discomforts or strains while using the TTS?

Yes _____ No __X__

Explanations/comments: When using the TTS I felt no more and probably less discomforts then when using the M32 or the 105D telescope.

5. What features did you like best about the TTS?

Explanations/comments:

6. What features did you dislike most about the TTS?

Explanations/comments: I disliked having to warm the sight, and the noise the cooling system made.

7. Would you recommend any changes to the TTS?

Yes _____ No __X__

If yes, explain:

8. Do you feel there are any unsafe features about the TTS?

a. Day Yes _____ No __X__

b. Night Yes _____ No __X__

c. Unusual weather conditions Yes __X__ No _____

d. Explanations/comments: It seems that the TTS is less as effective in thick fog.

9. Do you feel the average operator will be able to operate with this system equally as efficient as with any other system?

Yes __X__ No _____

Explanations/comments: Once you set the components initially you can just refer to these settings with ease in a minimum time expenditure.

10. Do you feel that the average repairman will be able to troubleshoot and repair this system?

Yes X No _____

Why? If he has the proper equipment.

11. Do you feel that the average operator will be able to:

a. Operate this equipment? Yes X No _____

b. Service this equipment? Yes _____ No X

c. Remove and install this equipment? Yes _____ No X

Explanations and comments: I don't feel the average operator will be able to service or remove and install the sight due to its complexity.

12. Are gauges, dials, scales, and numbers adequate for clear vision during:

Day operation? Yes X No _____

Night operation? Yes X No _____

Unusual weather conditions (e.g., rain, snow, sleet, fog, etc)?

Yes X No _____

Explanations and comments: All dials, gauges, scales and numbers are very accessible.

13. Must any attention be directed away from the target during adjustments of the TTS?

Yes _____ No X

Explain: The gunner doesn't have to refer to any. The tank commander gets the range.

14. Do you feel that instructions, labels, decals, etc., are adequate?

Yes X No _____

Explain:

15. Do you feel that warning instructions, labels, and decals are adequate?

Yes X No _____

Explain:

16. Do you feel that prolonged operations of the TTS would result in fatigue or eye strain?

Yes _____ No X

Explain:

17. Did you feel any fatigue or eye strain while operating the TTS?

Yes _____ No X

Explain:

18. Did you experience any after-effects from operating the TTS, i.e., headaches, vision, fatigue, or strains?

Yes _____ No X

Explain: